LOGISTICS SUPPORT FOR U.S. PERIMETER AND PORTAL MONITORING SITES IN THE SOVIET UNION

THESIS

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The opinions and conclusions in this paper are those of the author and are not intended to represent the official position of the DOD, USAF, or any other government agency.

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"Cast your cares on the Lord and he will sustain you; he will never let the righteous fall." (Psalms 55:22)

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Abstract

This research investigated logistics support for U.S. on-site inspection facilities in the USSR under the INF and START treaties. Specifically, the thesis examined logistics lessons learned from the operation of the U.S.'s Votkinsk Portal Monitoring Facility. A related area of interest was whether those lessons learned are useful for logistics planning for monitoring facilities under the START Treaty. Finally, the research described the distribution network used to move and store material for the Votkinsk facility, and whether that system could be used for a network of START facilities. Based on a literature review and personal interviews, lessons learned were outlined under eight different logistical areas, including maintenance planning; manpower and personnel; supply support; technical data; facilities; packaging, handling, storage and transportation; design interface; and planning. There was a near-consensus by experts interviewed that lessons learned from Votkinsk are valuable for planning logistics support of START facilities. One important conclusion from the lessons learned is that U.S. sites will have to import from the West almost all of what they consume since the Soviet economy cannot reliably provide even the most common comestibles at levels of quality taken for granted in western nations.

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I. Introduction

General Issue

The United States and Soviet governments appear headed toward agreement on reducing their strategic nuclear forces. If an agreement is reached and the Strategic Arms Reduction Treaty (START) is ratified, the United States will establish a number of Perimeter and Portal Monitoring (PPM) sites manned continuously by U.S. personnel (26). A precedent for such an arrangement was established by the Intermediate Nuclear Forces (INF) Treaty, which was signed by President Ronald Reagan and Party Secretary Mikhail Gorbachev in December 1987 (5:55). Since July 1988, each side has had one portal monitoring facility in continuous operation within the national boundaries of its treaty partner. The U.S. site is located at Votkinsk, U.S.S.R., a small city located about 600 miles east of Moscow in the foothills of the Ural Mountains; the Soviet site is located at Magna, Utah, just west of Salt Lake City.

The Votkinsk Portal Monitoring Facility (VPMF) is perhaps one of the most unique facilities operated by the U.S. Department of Defense (DoD). Manned by a cadre of five military officers and about 23 contract personnel, the facility uses an array of sensors, computers and measuring equipment to monitor Soviet compliance with the INF Treaty.

Operations at the Votkinsk site have required logistics support: maintenance, transportation and the supply of spare parts, consumables and food. If the START treaty is ratified, PPM sites operating under that treaty will require similar logistics support. However, the scope of the logistics network supporting the START sites will be significantly larger. Scattered across a wide area of the Soviet Union, there could be at least a half dozen sites with probably the same number of personnel per site as required for the Votkinsk site.

Specific Problem

U.S. logisticians planning the support of START PPM sites should understand the role of logistics in the support of continuously manned on-site inspection facilities in the Soviet Union. The Votkinsk facility -- the first and only one of its kind in the history of U.S. arms control -- significantly improved the learning curve for the operation and support of portal monitoring sites under on-site inspection regimes (26). As with any other weapon system, logisticians must be advocates for the maintainability, supportability and transportability of portal monitoring systems under START. They must understand the factors involved in the logistics support of Votkinsk Portal Monitoring Facility so that they can give informed advice to senior government officials regarding logistics issues in negotiations with the Soviets on support of the sites.

Investigative Questions

a. What are the logistics lessons learned from the deployment and operation of the U.S. portal monitoring facility at Votkinsk, U.S.S.R., under the INF Treaty?

b. Are Votkinsk logistics lessons learned applicable in planning logistics support for the deployment and operation of U.S. Portal Perimeter Continuous Monitoring Facilities in the Soviet Union under the START Treaty?

c. What is the distribution system that supports the Votkinsk Portal Monitoring Facility and how does it operate?

d. Can the distribution system used to support the Votkinsk portal facility be used to support similar facilities under START or will a new system be required?

Purpose

The purpose of this research is to provide a source of information to aid planning and negotiations for the logistical support of START PPM facilities.

Assumptions

The research is based on several assumptions. The first assumption is the premise that the VPMF is a useful model for logistics support of START portal sites. The second is that under the START Treaty U.S. sites in the Soviet Union will employ basically the same verification technology as the U.S. INF site at Votkinsk. Another assumption was that there would be approximately six U.S. START sites. The final assumption was that the each site would be manned by approximately 25 to 30 U.S. personnel.

Definition of Terms

1) Basing Nation: "A country other than the United States of America or the Union of Soviet Socialist Republics on whose territory intermediate-range or shorter-range missiles of the (treaty) Parties, launchers of such missiles or support structures associated with such missiles and launchers were located at any time after November 1, 1987. Missiles or launchers in transit are not considered to be 'located'." (22:2)

2) Inspected Party: In the context of inspections conducted in the Soviet Union and Eastern Europe, this means the Soviet Union.

3) Inspecting Party: In the context of inspections conducted in the Soviet Union and Eastern Europe, this means the United States.

4) On-Site Inspection: Negotiated measures which would enable information to be acquired from activities or sensors inside the territories of the nations party to an arms control or reduction treaty. The information would be for verification of compliance with the treaty by the inspected party (37:3).

5) Parties to the Treaty: The United States of America and the Union of Soviet Socialist Republics.

6) Point Of Entry(ies) (POE): Designated airport(s) within the sovereign territory of the inspected party or of a basing nation. Aircraft carrying inspectors and equipment of the inspecting party must land only at POEs, unless invited to land elsewhere by the inspected party. The treaty provides for only aircraft to transport inspectors between nations affected by the treaty.

7) Treaty Limited Items (TLIs): Missiles, launchers, support equipment and structures designated for elimination and prohibition by the INF Treaty, its protocols and Memorandum of Understanding.

8) Verification: As a technical term in the vocabulary of arms control, refers to the process of assessing compliance to the provisions contained in arms control treaties and agreements. It is an attempt to ascertain whether states are living up to their international obligations (6:2).

Background

In order to better understand the overall management issue, background must be given on the treaty, some of its costs to the American taxpayer, its significance, and how it ties into negotiations on the START treaty.

Interagency Structure for the INF Treaty. For policy and management overview of the treaty, the United States government has created an extensive interagency structure reporting to the President through the National Security Council. This structure includes the Department of State, the Department of Defense, the Department of Energy and the Arms Control and Disarmament Agency. DoD is charged with implementing the verification and monitoring provisions of the treaty (21:Sec II,1). Within the Defense Department, the On-Site Inspection Agency was created to conduct U.S. inspections in the Soviet Union and Eastern Europe and to escort Soviet inspectors in the United States and Western Europe (21:Sec II,4). The OSIA is a separate operating agency within the DoD made up of personnel from the four services. It has facilities in Washington; San Francisco; Magna, Utah; Rhein-Main Air Base, Germany; Yokota Air Base, Japan; and at Votkinsk, U.S.S.R. (71:51).

Types of On-Site Inspections. Portal monitoring is but one of five types of on-site inspections being conducted under the treaty. The United States and the Soviet Union have sent dozens of inspection teams to each other's country to implement provisions of the treaty. The type of inspections are as follows:

(1) Baseline Inspections. Each side provided an extensive data base on the missiles, launchers and facilities covered by the treaty. This included descriptive data such as quantities, dimensions and location of treaty limited items (TLI). The baseline inspections were used to confirm the data exchanged (91:16).

(2) Elimination Inspections. Each side must eliminate all its TLIs within three years of when the treaty entered into force. Each side must notify the other at least 30 days in advance when it plans to eliminate INF systems. Elimination inspections are to verify that the systems designated in the notice were indeed destroyed (91:17).

(3) Closeout Inspections. Once an INF facility has been eliminated, each side has the right to confirm that all prime mission systems and support systems and structures have been destroyed at the facility and that all related activities have ceased. Confirmation can be accomplished through national technical means or with a closeout inspection. If a closeout inspection is made, it must occur within 60 days after the announced elimination of the facility (91:17).

(4) Short-Notice Quota Inspections. These inspections are designed to complicate a treaty party's efforts to hide "military useful" numbers of TLIs. Until the TLIs are destroyed, they must be kept at declared locations and can't be moved without notice being given to the other side. While covert activity to undermine the intent of the treaty could be detected by NTM, short-notice inspections are allowed a specified number of times throughout the life of the treaty (91:18).

(5) Portal Monitoring. Under this inspection provision of the treaty, each side has set up a continuous portal monitoring facility outside a missile assembly plant of its treaty partner. The facilities monitor traffic leaving the plants to verify that TLIs are not being produced and deployed. Each monitoring facility can operate for up to 13 years (91:19).

Inspection teams are made up of ten personnel, except at Votkinsk where there are as many as 30 personnel, 23 of which are U.S. contract personnel (85:45). The same numbers apply for Soviet inspection teams (22:52).

Logistics Provisions in Treaty. The INF Treaty, as with all international treaties, can be viewed as a contract agreement between two or more nations. In addition to the many provisions regarding inspection activities, logistics obligations for each side are outlined in the INF Treaty, its protocols and related Memorandum of Understanding and Memorandum of Agreement.

Perhaps the predominant logistical area is transportation. Because of the nature of inspection activities, transportation, especially air transportation, is a key logistical element for implementing the treaty. Each side is responsible for transporting its inspection teams to Ports of Entry (POEs) located either inside the national boundaries of the "inspected party" or a third party nation (a "basing country) which has equipment and facilities that fall under the INF Treaty (22:49). From the POE, the inspected party is responsible for transporting inspectors to inspection sites. The POEs in the Soviet Union are at Moscow -- for inspection sites in the western U.S.S.R. -- and Ulan Ude -- for sites in the eastern U.S.S.R.. In the United States, the POEs are at Washington D.C. and San Francisco. For inspection sites in Europe, the POEs are at Brussels, Belgium; Rhein-Main Air Base, West Germany (Frankfurt); Rome, Italy; Schiphol, Netherlands, RAF Greenham Common, U.K.; Schkeuditz Airport, East Germany; and International Airport Ruzyne, Czechoslovakia (22:49). Under INF, the "inspected party" is obligated to provide "meals, lodging, work space, transportation and, as necessary, medical care" for inspection teams and aircrew members of the inspecting party (22:51). The host nation must also provide security, parking, servicing and fuel for aircraft carrying inspection teams and equipment. At Votkinsk and Magna, the host nation is also specifically responsible for providing construction support (materials, labor and equipment), and fuel, power, and water. The costs for logistical support in most instances is paid for by the host nation. The exceptions are 1) at airports, where the inspecting party must pay for fuel and servicing of inspection aircraft, and 2) at Votkinsk and Magna, where all logistical support is paid for by the inspecting party. This includes all transportation between the sites and their POEs -- Moscow (Votkinsk) and San Francisco (Magna) (22:51).

The Votkinsk Portal Monitoring Facility. The facility is located at the gate of the Votkinsk Machine Building Plant, a final assembly plant that at one time produced four different kinds of nuclear missiles: the SS 12, SS 20 and SS 23 intermediate range missiles, and the SS 25, which is a intercontinental ballistic missile (32:7). Now that the treaty is in force, only the SS 25 can be produced. The mission of VPMF personnel is to monitor traffic leaving the plant to verify that the treaty-limited items (TLIs) missiles are no longer being produced and deployed by the plant. Of key interest is the SS 20. It uses a stage that is very similar to a stage on the SS 25 (32:5). Also, the canister used to transport the SS 25 is large enough to carry the SS 20 (26). Inspectors are trained to use special equipment at the site to discern the difference.

Logistics support for the facility is provided primarily by Hughes Technical Services Company (HTSC), headquartered in Manhattan Beach, Ca. The company is a subsidiary of Hughes Aircraft Company. The Air Force Systems Command's

Electronic Systems Division awarded HTSC the Operations and Maintenance contract for the site in June 1988. Under the contract, the company is responsible for most logistics activities, including purchasing, warehousing, inventory management, maintenance, requisition (order) processing to include shipping documentation, supply, technical training of site contract personnel, food service (including purchase of food) and transportation to the Moscow POE (27:Atch 1).

Despite the contract provisions, the government has provided most transportation of equipment and supplies from designated ports of embarkation in the United States to Rhein Main Air Base, West Germany, the gateway for INF airlift missions to the Moscow POE. It has also transported most cargo and personnel between Rhein Main and Moscow. Between Moscow and the site at Votkinsk, the government is responsible for arranging transportation support from the Soviet government. The U.S. government also provided the prime mission equipment used at the site in addition to arranging for housing, electrical power, life-sustaining medical care and other items of logistics support to be provided by the Soviets in accordance with the treaty (27:Atch 1).

The Costs of the INF Treaty. Implementation of the INF Treaty has cost millions of dollars so far in acquisition of equipment and facilities, and for operations and support activities. Until Congress ratified the treaty in May 1988 and provided funding, the DoD had to reprogram funds -- with the approval of Congress -- or have the implementing DoD agencies absorb the costs of initial activities to carry out the treaty (71:47). The Defense Nuclear Agency provided about $2.2 million in operations and maintenance money for the fledgling OSIA from its own budget and from reprogrammed monies. The USAF Electronic Systems Division (Systems Command), which managed the acquisition and deployment of the Votkinsk portal monitoring system, was the conduit for almost $14.8 million in Air Force procurement and R & D funds (71:47). Following treaty ratification, Congress approved a Program Budget Decision (PBD) that moved $82.9 in reprogrammed O & M funds for treaty implementation. Although $67 million was earmarked for the OSIA, the slippage in ratification of the treaty by three months and with the use of the Military Airlift Command for airlift of inspectors, the OSIA only spent less than a third of the allocated funds (71:47). The FY 88 budget for the OSIA was $19.9 million and jumped to more than $50 million in FY 89. Budget requests for FY 90 and 91 were $49.8 million and $48.8 million, respectively (86:1).

Perhaps the most costly single inspection activity is portal monitoring because of the facilities, monitoring systems and long-term logistics support required. According to one estimate prepared by the OSIA for the Department of State, the cost of the Votkinsk portal monitoring system is $12,409,591 and does not include research and development, testing or system evaluation costs. Deployment, installation, operation and logistics support for the site from June 1988 to July 1989 cost more than $10 million (66:pages unnumbered). The real cost of the site is even higher. The figures above do not reflect R&D costs or the costs that will be billed to the U.S. government by the Soviets for site preparation and transportation costs they incurred for supporting the site (66:pages unnumbered).

Another significant cost in implementing the treaty is transportation. The OSIA reported that it paid MAC and commercial airlines approximately $11 million in FY 89 for the transport of Soviet and American inspection teams and their equipment. For FY 90 that total is expected to be $10 million, according to Wilbur Lewis who is chief of the OSIA's transportation section.

Transportation costs under the treaty have been significant because of the heavy use of airlift to transport inspection teams. Other lower-cost transportation modes are used, but airlift is preferred because of time schedules and the geographic separation of INF sites to be inspected. This is especially so for inspections in the Soviet Union which stretches across eight time zones and two continents. INF sites are scattered almost throughout the huge nation. In addition, there are dozens of INF sites in Europe and the United States.

In the first two months of the treaty during the baseline inspection period, MAC flew 101 missions, 81 into the Soviet Union, six to Eastern Europe and 14 in the United States when it carried Soviet inspectors to INF facilities. In the first year of the treaty, MAC flew missions in support of 340 inspections in both the United States, Europe and the Soviet Union (71:6).

Also, 30 days after the INF Treaty entered into force, the Defense Department had to have personnel and equipment on location continuously to monitor the missile assembly plant at Votkinsk. The initial cadre used portable equipment to monitor the plant. However, more permanent facilities were needed for the long term. Driven by scheduling and political considerations -- and given the nature of the Soviet transportation system, MAC and Aeroflot aircraft were used over the next 15 months to deploy more than 400 tons of equipment and supplies to Votkinsk. Three C-5 missions were used in addition to 12 C-141 missions and at least 12 Il-76 missions by Aeroflot. The cost of the airlift was approximately $1.1 million.[1]

Significance of the INF Treaty. The INF Treaty is the first treaty in history that will lead to the elimination of an entire class of nuclear weapons. Other treaties have only put limits on the growth in numbers of weapons each side could produce. The treaty is also the first between the two superpowers that allows for on site inspections. However, the real significance of the treaty is that it set

[1]Cargo totals were derived from cargo manifests for all missions except nine C-141B missions in January and February 1989. Those missions carried 89 pallets of furniture. An average weight of 4000 pounds per pallet was used.

a precedent for progress towards a reduction in the numbers of strategic nuclear weapons.

> The basic verification measures in the INF Treaty set a valuable precedent for a START agreement: the designation of areas and facilities where missiles and launchers are allowed; a detailed exchange of data on treaty-limited systems with frequent updates; and a variety of on site inspections (OSI) to confirm the baseline data exchange, observe the elimination of systems using agreed procedures, and confirm the numbers of systems at declared facilities. (1:55)

START Treaty. But there will be new ground to negotiate, and verification tasks under a START treaty will be much more complex. First of all, the START treaty will only reduce the number of nuclear weapon systems -- not eliminate them. There will be many more weapon systems involved and the characteristics of those weapon systems will be limited (5:55).

> Although the START verification provisions, in particular, build on the INF experience, they will be far more complex than similar INF provisions since the START Treaty will involve retention of a substantial number of systems (which will likely need to be tracked by some form of tagging), a greater number and variety of weapons systems, and air and naval, as well as ground-launched, systems. (71:23)

Because of the greater numbers of weapons that are addressed in the START Treaty, there will be many more manufacturing and assembly facilities, bases, storage sites and other locations that could be inspected and monitored. But how many treaty inspection locations will each side push for? Of course, there will be political and security considerations. But what about economic considerations? Each nation may feel compelled to conduct cost-benefit analyses to determine the level of inspection/monitoring activities that can be reasonably budgeted to assure a given level of confidence in verifying the other side is not cheating. The costs could be in the billions of dollars over the life of the treaty.

> The U.S. is grappling with how much verification will be necessary to ensure Soviet compliance with pending arms control treaties, given the high costs involved. Arnold L. Kantner, a National Security Council official, estimated the On-Site Inspection Agency's budget would climb by as much as $200-300 million per year. The cost of counter-intelligence activities would rise $200-$500 million annually as a result of START and CFE agreements. Under START, on-site monitoring of just one pair of production facilities -- one on each side --would cost $500 million over 15 years. Kantner said spot inspections would cost about $1 million each (87:17)

Amy F. Woolf, a national defense analyst with the Congressional Research Service of the Library of Congress, made similar conclusions about the long-term costs on monitoring treaty compliance by the Soviets.

> The United States will have to develop, buy, and operate the equipment used during inspections and at portal monitoring sites, pay the salaries of U.S. inspectors and escorts for Soviet inspectors, and cover the costs of the transportation and support for U.S. inspectors. Although no firm estimates exit, these costs could range into the hundreds of millions of dollars annually. (91:43)

The peace dividend expected from better relations with the Soviet Union will come -- but with some start up costs. One thing that has become clear to policy makers inside and out of the Defense Department is that it will cost billions of dollars for the U.S. to "trust but verify" nuclear arms control treaties with the Soviets. Neither side can afford to set up a portal monitoring facility outside every facility involved in the production of nuclear weapon systems. With the Votkinsk INF portal site and, for example, four START portals, operations and support costs could be around $2.5 billion or more over the life of the treaties. And, as stated previously, portal inspections are only one of five types of on-site inspections that are likely to be conducted under START. The challenge for the U.S. government will be to determine how much verification is enough given political and fiscal considerations. The challenge for logisticians planning support of the START portal sites, will be to apply lessons learned from the INF Treaty so that total logistics costs are minimized and optimum support is provided.

Scope of the Research

This research deals with only lessons learned for logistics support. There are dozens of lessons learned from the INF treaty in other areas besides logistics. Also, the research only seeks to study the physical distribution segment of the logistics pipeline for the Votkinsk portal, and use that as a basis for making conclusions and recommendations regarding the distribution system for START portals.

Sequence of Presentation

Chapter II discusses the methodology of this thesis, which is a combination of the historical and survey methods.

In the discussion, the advantages and disadvantages of each method are given. Also, the chapter presents a discussion of why the concept of integrated logistics management is essential in understanding logistics support of treaty monitoring sites under the INF and START treaties.

Chapter III will be a literature review consisting of four sections. The first will review the literature on integrated logistics management with an emphasis on physical distribution systems. The second and third sections will present information on the transportation links used by the On-Site Inspection Agency to move personnel, equipment and supplies between the Votkinsk portal site and facilities in West Germany and the United States. Those transportation links are the Defense Transportation System of the United States and the national transportation system of the Soviet Union. The fourth and final section provides information on the concept of "Integrated Logistics Support (ILS)" and the ten basic elements of ILS. The concept is at the core of acquisition logistics management in the Department of Defense systems acquisition community. The ILS elements will be used as a framework in Chapter 3 for presenting logistics lessons learned from support of the Votkinsk portal site.

Chapter IV will be an analysis of structured personal interviews with U.S. government officials and managers with the HTSC program office for the Votkinsk facility. The interviews, along with documents and reports from government agencies and contractors, will provide information on logistics lessons learned. This will be augmented with information from telephone interviews with U.S. and Canadian businessmen regarding their observations on the distribution of goods in the Soviet Union. Their observations were sought as background for evaluating logistics lessons learned for Votkinsk and to determine if there are any parallels between their experiences and those of the U.S. government. As stated earlier, the information will be presented within a framework of the ten basic elements of ILS. The interviews will also provide information on whether those logistics lessons learned are applicable to the START Treaty. Government officials and contractor personnel were asked for their expert opinions on whether or not the Votkinsk experience is a basis for planning support of the START portals. The chapter will also present information on the operation and characteristics of the logistical network that supports the Votkinsk portal site, and whether or not that network can support portal monitoring sites under the START Treaty. The information is from the structured interviews, and documents and reports from government agencies and contractors.

Finally, Chapter V will present conclusions about logistics support for the Votkinsk portal facility and give recommendations for logistics planning for support of the START portal sites.

II. Methodology

Particular Method

The research took "logistics lessons learned" from the INF treaty, and other information on the logistics factors of arms control and reduction, and synthesized it to provide a logistics planning source for the START Treaty. To accomplish this, a combination of two research methods was used. The first was the historical analysis method and the second the survey method -- specifically, interviews with experts. This research design was driven by the fact that political and economic events of 1989 and 1990 in Europe, the U.S. and U.S.S.R. have quickened the pace of arms reduction talks. Assumptions and factors behind these talks are changing so rapidly that published material and opinion have not been keeping pace with the dynamics of world events driving arms control and reduction.

Another factor beside the time lag was that written material on logistics support for arms treaty verification activities was not publicly available. There was a great deal of uncertainty on the part of the researcher about how much was written on logistics support factors and where the documents were located. Therefore, the research could not be based solely on the historical method. Interviews were needed to provide opinions, attitudes and insights of experts regarding logistics support of U.S. arms control inspection sites in the Soviet Union. Further, their opinions were needed to derive the type of verification systems that could be employed under the START Treaty.

A description of each research method follows:

Historical. The historical analysis method is a lessons-learned-from-history approach to answering the research question. It involves "defining the problem, gathering the data, and evaluating and synthesizing the data into an accurate account of the subject investigated" (9:261).

The method provided an overview and historical background on key issues affecting logistics support for nuclear arms control treaties between the United States and the Soviet Union. Information was gathered from the INF Treaty, its protocols and related memorandums of understanding and memorandums of agreement between the United States and the Soviet Union. Information was also gathered from documents related to START treaty negotiations, and from more general documents on political, diplomatic, and management issues regarding the treaties. Further, a review was made of internal documents of U.S. government and private organizations on the actual management of logistics activities in support of the INF treaty verification. Also, written information was requested through the West German government regarding work by West German companies on air cargo terminals in the Soviet Union. In addition, officials at the Aeroflot office in Washington were contacted for information on the freight handling capabilities of the airline. Finally, information was gathered on integrated logistics management and logistics systems.

Survey. The purpose of the personal interviews, as stated earlier in this chapter, was to update and add depth to information gathered under the historical method, and to provide detailed insights, opinions and observations from experts on factors affecting logistics support. According to C. William Emory, the personal interview survey method's "greatest value lies in the depth and detail of information that can be secured." He went on to say:

> It far exceeds the information secured from telephone and mail surveys. The interviewer can also do more things to improve the quality of the information received than with other methods. Interviewers can note conditions of the interview, probe with additional questions, and gather supplemental information through observation (29:160)

Interviews were conducted with selected leaders within the DoD, the Arms Control and Disarmament Agency, and the Hughes Technical Services Company regarding their work on the START and INF treaties. In addition, interviews were made with business leaders in the United States and Canada who are either doing business in the Soviet Union or who have toured Soviet distribution facilities. During the interviews, U.S. government officials were asked for their opinions and insights into the operations of technical onsite inspection sites and what type and level of logistics support was required. Since Hughes Technical Services has the operations and maintenance contract (to include logistics management) for the Votkinsk site, their experts were interviewed to gather information regarding inventory, maintenance and food service management.

Telephone and face-to-face interviews were conducted. The telephone interviews were conducted first, and were often used to set up personal interviews and to gather preliminary and follow up information. This helped reduce the high cost associated with the personal interview method. According to Emory, using the telephone to set up personal interviews is a good approach to reducing these costs, which are the primary drawback to the personal interview method (29:161,167-168)

The information from the telephone interviews was used to write interview guides containing "measurement" questions for the personal interviews. The interview guides were reviewed by faculty members of the Air Force Institute of Technology. However, the researcher felt free to ask questions not in those guides, particularly in order to follow up on answers that provided information on areas not recognized as important beforehand by the researcher.

In some instances, face-to-face interviews could not be held with experts because of scheduling problems. In these instances, telephone interviews were conducted using the same interview guide as used for face-to-face interviews.

Integrated Logistics

A benchmark was used for gathering and understanding information on the distribution system supporting the

Votkinsk Portal Monitoring Facility. That benchmark was the concept of integrated logistics management. Literature on integrated logistics was reviewed with special emphasis on physical distribution. At the heart of integrated logistics is the concept of providing a given level of customer service at the lowest total logistics cost. The concept states that managers must consider the logistical components of warehousing, inventory, order processing and transportation as a system where cost tradeoffs are made between the components to arrive at the lowest total logistics cost to meet service requirements determined by the mission and objectives of the organization. While most literature is primarily focused on profit-making business organizations, the concept also applies to non-profit organizations, including the U.S. Government.

There must also be a structure or framework for gathering and evaluating information on logistics lessons learned. The framework used was the ten basic elements of Integrated Logistics Support (ILS). These concepts were used as templates to help organize discussion, analysis and conclusions about logistics factors and lessons learned from documents and reports and from personal interviews.

III. Literature Review

Overview

The first section of the chapter looks at integrated logistics management, which is a systems approach to moving and storing material at the least total cost to meet organizational goals. An overview of integrated logistics management will be given, followed by a review of the aspects of least-total-cost network design. The purpose of the section is to provide a bench mark for understanding the distribution network supporting the Votkinsk Portal Monitoring Facility and to be able to answer whether or not that same network can support similar facilities under the START Treaty.

The next two sections examine the transportation linkages in the distribution system supporting the Votkinsk Portal Monitoring System. Equipment, personnel and supplies for Votkinsk are moved by the U.S. Defense Transportation System and the Soviet national transportation system. Pertinent aspects of those transportation systems will be discussed in order to understand factors affecting the overall logistics support of portal sites under the INF and START treaties.

The final section of this chapter is a bridge to Chapter 4, where information on logistics lessons learned will be presented. A framework for presenting those lessons is needed. That framework will be the ten elements of integrated logistics support. The literature review will present an overview of the ILS concept and short explanations of the ten ILS elements.

Integrated Logistics

Much of the literature concerning integrated logistics primarily focuses on profit-oriented organizations. However, several leading authors in the logistics field, Bowersox, LaLonde and Stock and Lambert, state that their writings are also applicable to non-profit organizations such as the military services. Before the main stream literature on integrated logistics is reviewed, a definition of military logistics will be given along with a comparison between military logistics and business logistics.

Military logistics is defined by JCS Publication 1 as:

> The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations which deal with:
> a. design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel;
> b. movement, evacuation, and hospitalization of personnel;
> c. acquisition or construction, maintenance, operation and disposition of facilities; and
> d. acquisition or furnishing of services. (88:11)

Definitions of business logistics are more narrow in focus. Most describe logistics as the efficient and cost effective management of the movement and storage of inventory from the point of origin to the point of consumption to meet customer requirements. Besides a narrower focus, there are other differences between military and business logistics. The first is performance measurement. The performance of a business logistics system can be measured in terms of profit. La Londe states that in terms of each dollar of sales, logistics is the third largest expense of doing business (53:23). If those logistical costs can be reduced while maintaining sales volume, then profit -- the difference between revenue and cost -- will increase. For a military logistics system, economic profit can not be used to measure performance. The system operates under a fixed budget condition where income (budget line) should be equal to or greater than operating costs. Also, the military logistical system must be able to surge to meet wartime requirements. The logistical operation of a civilian firm is usually rationalized and operates at near capacity to increase efficiency. The final difference is size. The military logistics system is much larger than any single firm, and this size contributes to the complexity of military logistics (84).

But there are at least five similarities between military and civilian logistics. The first is that each creates time and place utility (value), which will be explained later in this chapter. The second is that the customer service concept is valid for both. In military logistical terms, "customer service" is often synonymous with "mission requirements," so the concept is basically the same. Efficiency is a third similarity. Managers of each system seek to increase the output of each system at a given level of inputs (resources). The fourth similarity is that both systems incur costs in creating time and place utility, which leads to the final similarity: both systems have as their objective to minimize total logistics costs (84).

Because of the many similarities between the two systems, the literature on integrated logistics management does provide an applicable theoretical base for understanding the distribution system supporting U.S. portal monitoring facilities in the Soviet Union.

According to Bowersox, Closs and Helferich, management practices in the United States have changed dramatically regarding the logistical process (10:3). No longer are logistical activities such as transportation, warehousing, inventory management or order processing treated independently from each other. It is now becoming more common to take an integrated approach when managing the logistical process. This new view of logistical management has reached the point where Bowersox, et al, state that there is a "modern" definition of logistics:

> A single logic to guide the process of planning, allocating and controlling financial and human resources committed to physical distribution, manufacturing support and purchasing operations. (10:3)

The authors also stated that the term "logistics" is universal and applies to both profit-oriented businesses and non-profit organizations such as the military services.

There are several other terms and definitions of "logistics" in trade journals and textbooks. In fact, Stock and Lambert point out that in the 1980s there were a variety of names for the concept of logistics, including physical distribution, business logistics, distribution logistics, materials management, Rhocrematics, and others. Stock and Lambert stated that all the terms essentially refer to the same idea, which is the "management of the flow of goods from point-of-origin to point-of-consumption" (78:6). The authors use the term "logistics management" to describe the flow and have adopted a definition by the Council of Logistics Management, one of the largest and most respected professional organizations for logisticians:

> The process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of origin to point-of-consumption for the purpose of conforming to customer requirements. (78:7)

There are fourteen logistical activities associated with the definition: customer service, demand forecasting, distribution communications, inventory control, material handling, order processing, parts and service support, plant and warehouse site selection, procurement, packaging, return goods handling, salvage and scrap disposal, traffic and transportation, and warehousing and storage (78:8).

LaLonde uses the term "business logistics" instead of "logistics management." While his definition of business logistics is similar to the definition of logistics management, he includes "acquisition" as an activity in addition to the movement and storage of goods (53:16).

LaLonde states that his definition is based on the "science of military logistics" and, as such, he added "personnel movement" to the list of logistical activities mentioned by Stock and Lambert (53:18).

According to LaLonde, the concept of integrated logistics ties together two logistical activities and results in a system. He states that integrated logistics is:

> An approach to the distribution mission of the firm whereby two or more of the functions involved in moving goods from source to user are integrated and viewed as an interrelated system or subsystem for purposes of managerial planning, implementation, and control. (53:18)

Stock and Lambert state that the foundation of integrated logistics management is "total cost analysis," which is minimizing the total cost of logistical activities while meeting or exceeding a planned level of customer service (or mission requirement). The cost of these logistical activities are classified under transportation, warehousing, inventory, order processing and information systems, and lot quantity. These activities must be administered by managers as part of an integrated system. By centrally coordinating these activities, managers are able to force "cost tradeoffs to be made between and among customer service levels, transportation, warehousing, inventory management, order processing, and production planning and/or purchasing" (78:39-41).

General Systems Theory. Theoretically, integrated logistics is based on the General Systems Theory. The theory states that a "system" is:

> A set of objects together with relationships between the objects and between their attributes related to each other and to their environment so as to form a whole (89:4).

All systems have an environment that they operate in. An environment is everything that can affect the system. In open systems, the environment provides inputs to the system. The inputs are processed by the system's components or activities ("objects"), which function to transform the inputs into system outputs. The outputs are what the system was designed to produce.

It is important to understand that the components are tied together or relate to each other. There are three kinds of relationships including 1) "symbiotic" where one or more of the system components rely on each other for survival; 2) "synergistic" where the combined functioning of the components produces a result -- total output -- which is greater than the sum of individual outputs if the system components were operating independently; and 3) "redundancy" where one or more components can perform the same function (89:5-6).

Logistics Systems. Stock and Lambert, and Bowersox, Closs and Helferich gave representations of logistical systems. The Stock and Lambert logistical system was more general in nature than the system given by the Bowersox group, and emphasized the managerial control of logistical activities in an integrated process that transforms environmental inputs incrementally in three stages: raw material, work-in-process and finished goods. The primary outputs are competitive advantage, time and place utility, efficient movement to the customer and proprietary asset. The system is shown in Figure 1 below.

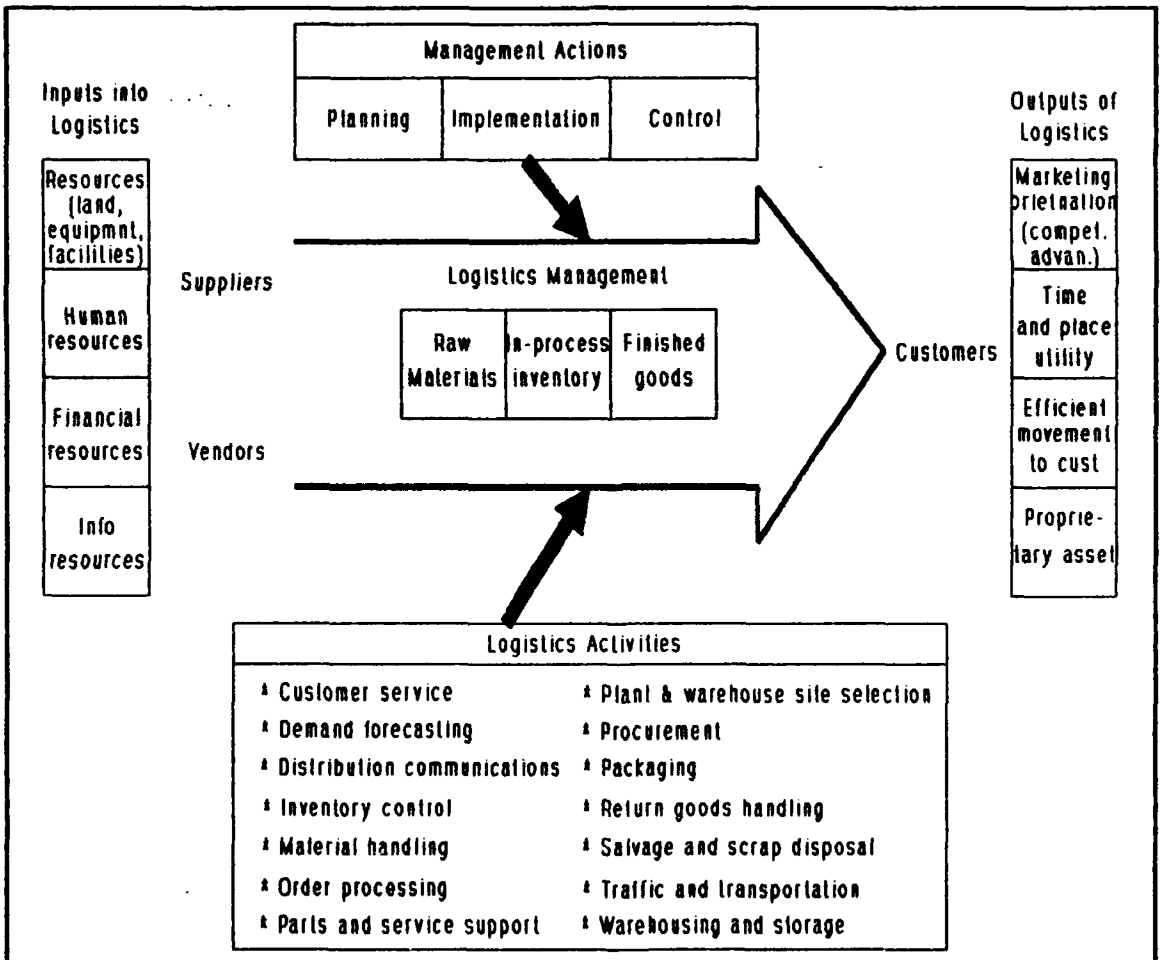

Figure 1. Stock and Lambert Logistics System (78:8)

The Bowersox group's system emphasizes interrelated flows of requirements information and value-added inventory. Requirements information flow is in the form of forecasts and customer orders. These trigger planning objectives and the beginning of the flow of inventory toward the customer in an incremental process that results in the delivery of a product. The system is actually a series of three integrated logistics subsystems, purchasing, manufacturing support, and physical distribution, with each subsystem engaging in more than a dozen logistical activities. Management control is essential in integrating the processes of the three subsystems, which link the organization to its customers and suppliers. According to Bowersox, Closs and Helferich, the logistical system is applicable to both profit and non-profit organizations, and organizations that don't have a manufacturing process -- such as retailers or wholesalers.

The authors also emphasize that there is a reverse logistics flow in the system to accommodate product recalls and the replacement or repair of warrantied items (10:16). For a military logistics system, this could also mean the return of aircraft pallets, reparable items and reusable containers. The logistical system is outlined in Figure 2 on the next page.

As mentioned above, there are three logistics subsystems in the Bowersox group's integrated logistics system. However, the physical distribution subsystem serves as the

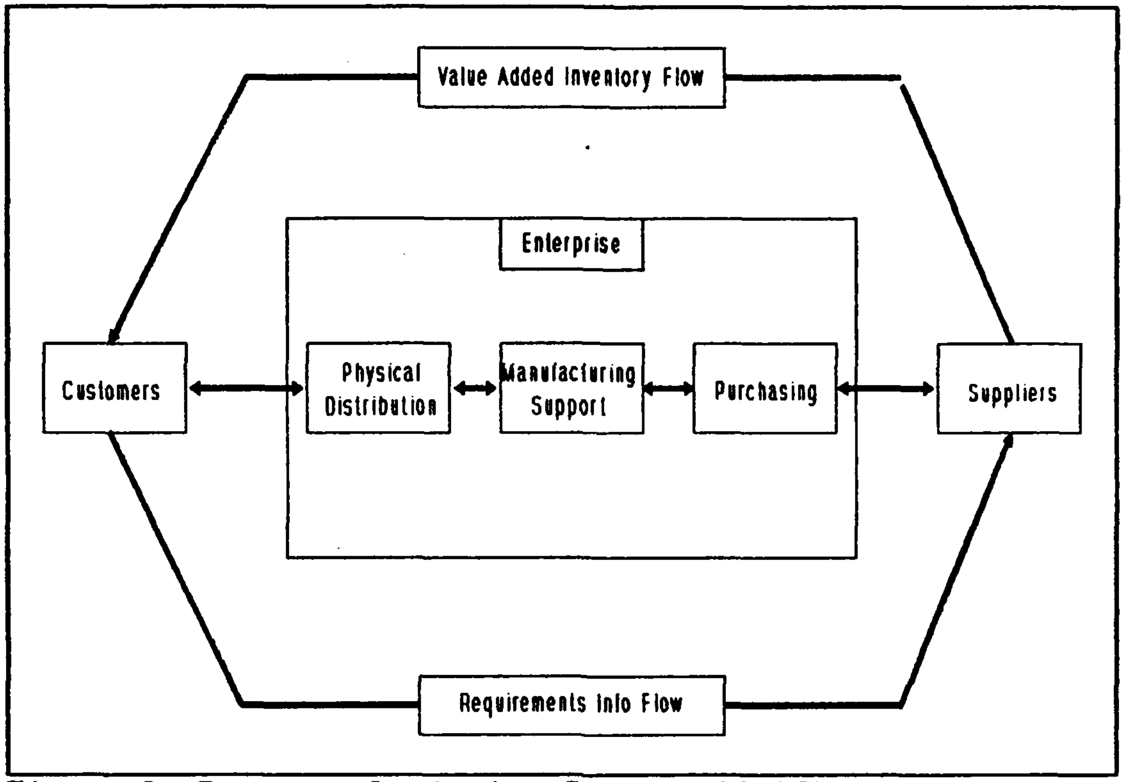

Figure 2. Bowersox Logistics System (10:16)

most applicable theoretical model for this research, which focuses on the distribution of finished goods and supplies between logistics facilities operated under contract for the DoD in support of treaty implementation. Therefore, only the physical distribution subsystem will be defined:

> The process of providing customer service. Requires the performance of order receipt and processing, deployment of inventories, storage and handling, and outbound transportation within a channel of distribution ... The primary physical distribution objective is to assist in revenue generation by providing strategically desired customer service at the lowest total cost. (10:19)

The basis for the movement and storage of inventory in support of strategic objectives is requirements information flow. It is concerned with determining where and when specific items of inventory will be required within the logistics system to support mission requirements. The objective of requirements information flow is to allow the logistics system to effectively respond to different situations and demands regarding order size, availability of inventory and urgency of movement (10:18-19). There are two areas of requirements information flow concerning planning and coordination of logistics operations. They are forecasting and order processing. Forecasting is compiling statistical estimates of future inventory requirements. Most procurement and distribution activities are in anticipation of future requirements, and forecasting is an attempt to "program or postpone" those logistical activities in order to control the associated costs. While forecasting is planning for the future, order processing is a response to the "here and now." A customer order/requisition is a "realization" of forecasted requirements and triggers the distribution process, which culminates in the delivery of the good ordered by the customer (10:19-20). That process is the order cycle.

Time and Place Utility. The primary outputs of a logistics system are time utility and place utility. They represent two of the four economic utilities (values) added to a product before it is used by a customer. The other utilities are form and possession utilities (10:71-72). Form utility is provided by manufacturing systems. Manufactured products are more valuable to users than the subassemblies and raw materials used in their manufacture. By transforming these inputs into finished goods, manufacturing creates "form utility." Marketing adds "possession utility" by informing potential customers of a product's availability and by facilitating the exchange of the product between the firm and the customer. But manufactured products with effective marketing support are of little value to users if they are not in the right place at the right time in the right condition. Logistics adds value to products by making them available where the users are at the time they need to use the product. "Place utility" comes from making the product available for consumption in the right place while "time utility" comes from making a product available for consumption at the right time (78:9-11).

Why Integrated Logistics Management? For many years logistical activities were managed by different directorates within an organization. Often, for example, manufacturing controlled inbound transportation, and some inventory and warehouse activities; accounting oversaw order processing; the traffic management function managed outbound transportation; and marketing/sales controlled positioning of inventories. Each directorate had its own budget, politics and priorities. There was little coordination between departments, and each sought its own low cost solution or tactic to boost the level of customer service. According to Stock and Lambert, the result for the firm is often higher total logistics costs and perhaps lower customer service levels as each department pulls in its own direction. Reducing inventory levels and the number of warehouses will often increase transportation and order processing costs. Consolidating shipments to achieve lower per unit transportation costs will increase the amount of inventory on hand and the associated inventory carrying costs. Reducing inventory carrying costs and transportation costs may lower the level of customer service for profit oriented organizations, resulting possibly in lost sales -- which is a cost (78:45-46). For the military, reducing inventory investment and transportation costs could result in lower levels of mission readiness -- which is a non-quantitative cost.

According to Bowersox, the mission of the integrated logistics function of an organization is to develop a system that meets the strategic objectives of the organization at the least possible cost. As a result, logistics planners must balance service performance and total costs in designing an integrated system that is responsive to the logistical requirements of the organization (10:27). This interrelationship between logistical system cost components and customer service objectives is illustrated by Figure 3 on the next page.

The total performance of a logistical system is a question of priority and cost. Bowersox states that as long as money is no object, an organization can have any level of

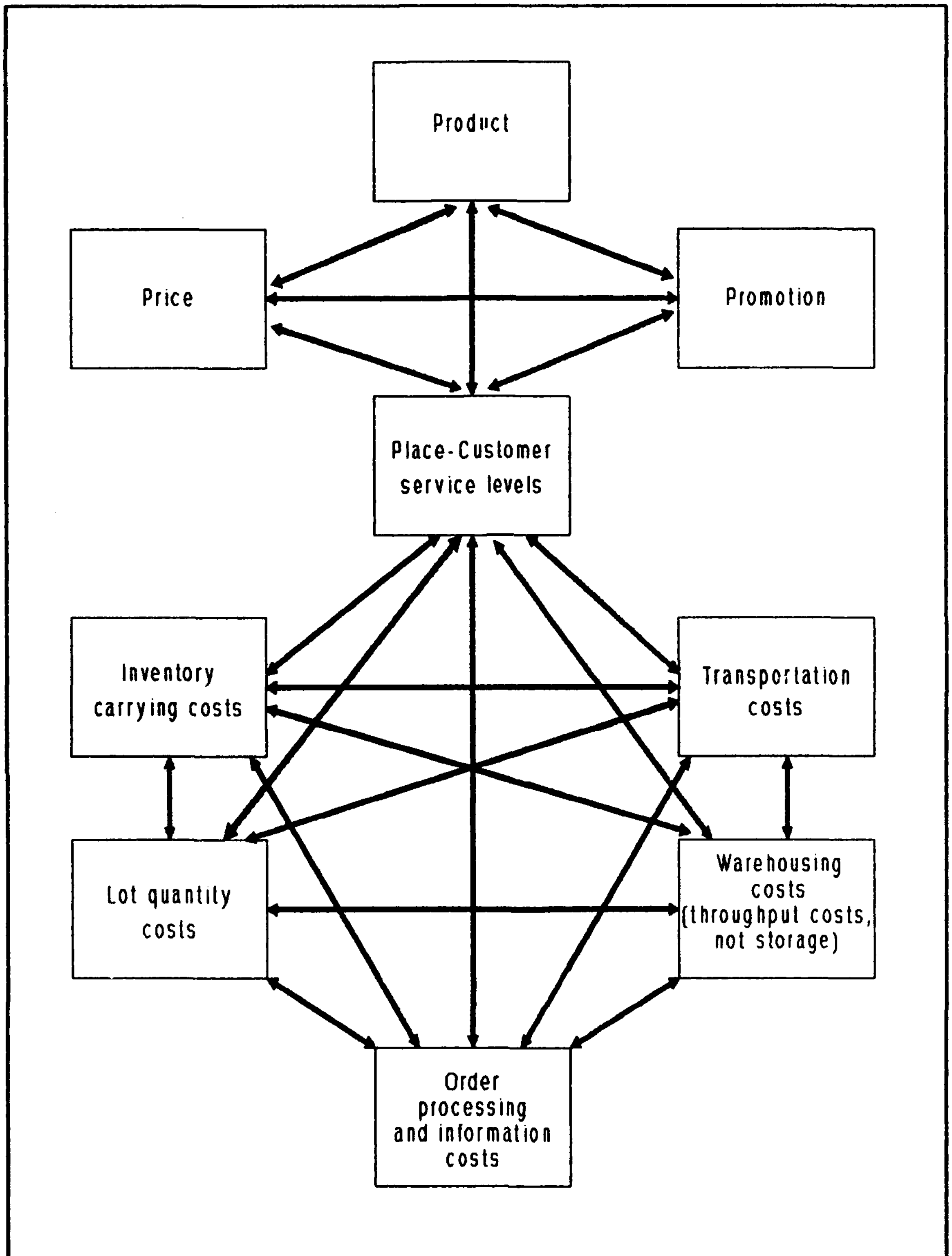

Figure 3. Tradeoff Model. Logistics goal: Minimize total cost at given customer service objective. Total cost = Transport costs + warehouse costs + order processing and info costs + lot quantity costs + inventory carrying costs. (78:42)

logistical service. A fleet of trucks or aircraft can be standing by to move products to important customers within hours after their order; a nationwide network of warehouses can be established with inventories of every product line the firm produces; or there can be dedicated communications lines between the firm and most of its customers to speed order processing. But a firm's resources are limited, and the "priority placed on performance should be directly related to impact of failure" (10:27). The penalty of failure is much greater if a logistics system can't respond in a timely manner to providing a critical spare part for a military aircraft on alert than if can't respond to a demand for office supplies.

Bowersox stated that the performance of a logistical system is measured against three criteria: availability, capability and quality. He said availability is the "system's capacity to consistently satisfy" demand requirements. This usually means that higher levels of customer service (fewer stockouts) will require higher levels of inventory investment. "Capability" refers to the quickness and consistency of the logistics system in responding to a customer order. Bowersox said fast deliveries are of little value to customers unless they are consistently made. Finally, "quality" refers to how well a system can deliver the goods in terms of damage, correct items ordered and response under unusual conditions (10:27-28). Fast delivery of baseball bats means nothing to a customer if he ordered tennis rackets (10:27-28).

As stated earlier, integrated logistics is based on the concept of total system costs. Therefore, for analytical purposes, the logistical system employed by an organization should be viewed as a cost center where management seeks to minimize expenditures across the entire system. However, there is a tradeoff between logistical performance and the pursuit of minimum total logistics cost.

> The level of total cost has a direct relationship to the customer service policy. The simultaneous attainment of high availability, capability, and quality is expensive. The higher each of these aspects of total performance, the greater the cost of logistical operations. (10:28)

The relationship between level of logistical performance and logistical cost is not linear -- it is curvilinear. As an example, an organization is seeking to improve by 5 percent the consistency at which it is able to deliver spare parts overnight from a central warehouse to an airfield 2000 miles away. Presently, it is able to accomplish that support for 90 percent of the demands. However, in seeking that higher customer service level, it may have to double its logistics costs. Bowersox comments that organizations have to carefully assess the costs of higher customer service levels and their impact on profit margins, judging whether or not customers need, want or value that extra service (10:28). For the military, commanders must decide whether the added logistics costs of increasing the readiness of unit weapons systems by a certain percentage are outweighed by the benefits of that additional readiness.

The best logistical policy for an individual organization is one that is not at either end of the performance-cost logistics continuum. At one end is lowest total cost/lower service performance; at the other end is highest total cost/higher service performance. Management must conduct cost-performance tradeoffs to balance "reasonable performance levels and realistic cost expenditures" (10:30).

<u>Distribution System and Interaction of Components.</u> The customer at the Votkinsk portal facility more often than not will be a technician doing maintenance on a piece of prime mission or support equipment. He or she may also be a cook planning next month's menu and making a food order. That customer may also be the assistant to the site commander making a requisition for office supplies. Their requisitions or orders set the distribution system in motion, triggering a series of interactions between system components. The components include (1) facility structure, (2) order management, (3) transportation, (4) inventory, and (5) warehousing (10:20).

Facility structure refers to a network of facility locations within a distribution system through which materials and products flow (10:21). Logistics facilities include consolidation and distribution centers; warehouses; branches; freight terminals; and salvaging, re-cycling, and maintenance centers (7:146).

> They [logistics facilities] transform them [finished products] through physical operations such as repacking and order assembly, and add value to them by making them available at strategically located points. Furthermore, they allow the consolidation of freight, thus producing savings in transportation costs and improvement in delivery times. (7:146-147)

A solid network of facilities is the basis of an efficient distribution system since the layout of the network drives transportation and order processing requirements and affects the level of inventories (10:21).

Around the world, there are a variety of ways that materials and products flow through the facilities network of a physical distribution system. Each system must be flexible in how it balances performance and cost in meeting the unique requirements placed upon it. Despite the differences between the various systems, there are two basic characteristics that all share. The first is that all are designed to encourage maximum inventory flow. The second is that the systems are shaped according to the technological constraints of their logistical components. These constraints result in common patterns in the way inventory items flow through a facilities network. The three common patterns are (1) echelon systems, (2) direct systems, and (3) flexible systems (10:53-54).

The first two systems appear to best fit the operation of the distribution system supporting Votkinsk or one that may support multiple sites under the START treaty.

> The term "echelon" implies that the flow of products proceeds through a series of consecutive locations as it moves from origin to final destination. Such steps involve positioning inventory in warehouses. The essential characteristic of an echelon system is that finished goods inventory is stocked at one or more points prior to final destination shipment. (10:54)

Two key facilities (nodes) of an echelon distribution system are break-bulk and consolidation warehouses. They are the basis of two common echelon patterns. Break-bulk warehouses usually receive large-volume shipments from a variety of vendors. The warehouse breaks down the inbound shipments and resorts them into combinations required by individual customers. Once this is done, the smaller shipments are moved to the customer. The other pattern is based on consolidation warehouses. This type of warehouse consolidates small inbound shipments from various vendors into a single, larger outbound shipments to individual customers (10:54).

> Echelon systems employ warehouses to provide inventory assortments and achieve low transportation rates. Additionally, inventories held in warehouses are available for rapid customer delivery. Rapid delivery can be accomplished without a warehouse network by using premium transportation. However, when volume is sufficient, a network of strategically located field inventories often provides the best balance of cost-service performance (10:54)

Under the START Treaty, one central stocking location could be used to support the requirements of, for example, four portal and perimeter monitoring facilities that would be established. The stocking location (warehouse), would operate direct to each site by filling orders from inventory centralized there. This type of distribution system is called a "Direct System," and it contrasts the echelon system because customer orders are filled by a central warehouse rather than by vendors. Under the system, premium transportation and advanced order processing systems are used to overcome geographic separation from customers. These systems could be used as part of forward buying strategies that may be used for spares support of the START portal sites. The Bowersox group stated that direct systems are "commonly used in purchasing materials because of the large average size shipment from vendor to purchasing source (10:54)

> The overall potential to increase the number of direct-distribution shipments has basic appeal because it eliminates inventory commitment and multiple handlings. The limiting element to direct distribution is the high cost of transportation and potential loss of control. Advances in electronic communication capabilities are rapidly changing the situation. Today, technology exists to maintain control as well as reduce the labor-intensive nature of processing many small orders for direct delivery ... direct delivery is predicted to become the least-cost physical distribution solution in an increasing variety of situations. (10:54)

In a logistical network, facility structure has a direct impact on transportation, which is one of the most costly and significant components of a physical distribution system (80:12). Facility structure determines the nature of the transportation requirements of a logistics system since, as Bender stated, transportation "establishes the links" between logistics facilities and between those facilities and the market where the customer is (7:147). Bowersox, Closs and Helferich state that facility structure limits the range of transportation options (10:23). Therefore, management must analyze the relationship between facility structure and transportation in designing logistical network.

There are three factors which are important in establishing transportation linkages for a network of logistical facilities. They are (1) cost, (2) speed, and (3) consistency. Cost must be balanced against the other two factors which, together, are referred to as quality of service (10:23). Each of the factors will be discussed along with their interrelationships.

The costs associated with transportation are incurred two ways: the first is the expense of moving personnel and products between two points; and the second is the inventory expense of having products and material unavailable for use because they are in-transit. While a logistical system should minimize transportation costs in relation to total logistics costs, that does not necessarily mean that the least expensive transportation service should always be used (10:23).

As stated earlier, the quality of transportation service is measured in terms of speed and consistency.

> 'Speed' of transportation service is the time required to complete a movement between two locations. Speed and cost are related in two

ways. First, transport specialists capable of providing faster service will charge higher rates. Second, the faster the service, the shorter the time interval during which materials and products are captured in transit. (10:23)

"Consistency" of service may be the most important consideration in establishing transportation support. The Bowersox group said this:

> Consistency of transportation service refers to the variance in time for a number of movements between the same locations. In essence, how dependable is a given method of transportation with respect to time? In many ways, consistency of service is the most important characteristic of transportation. If a given movement takes two days one time and six the next, serious bottlenecks can develop in the flow of goods which impair inventory control. If transport capability lacks consistency, inventory safety stocks must be provided to protect against service breakdowns. Transport consistency influences both the seller's and buyer's overall inventory commitment and related risk. (10:23)

The flow of inventory items through a logistical network is driven by the inventory policy of an organization. That policy should reflect the strategic goals of the organization in meeting its mission requirements. Conceivably, an organization could have an inventory policy that allows every inventory item to be stocked in the same quantity at every logistics facility. The risk of not having an item immediately available where it is demanded would be eliminated. However, the total logistics costs would be prohibitive, and would not be cost-effective in support of mission objectives. On the contrary, inventory policy should be to maintain the lowest possible inventory levels consistent with pre-determined levels of customer service -- meeting mission requirements -- at the lowest total logistics cost. Just-in-case inventories result in higher than necessary total costs and may hide flaws in the distribution system. As Bowersox, Closs and Helferich state, logistics policy "should be initiated with the objective of committing as few assets to inventory as possible" (10:23-24).

For a non-profit organization such as the OSIA, inventory should also probably be deployed selectively in order to reduce inventory investment and associated carrying costs. Stock, Lambert, Bowersox and others all relate how sound inventory policies are based on certain factors. For instance, Bowersox, Closs and Helferich state that there are five factors which should be considered, which include customer qualities, product qualities, transport integration, manufacturing concerns and competitor performance (10:24). In the case of a logistics system such as the one supporting Votkinsk or a network of START sites, two of the factors apply, and they are product qualities and transport integration.

Product qualities refers to the profitability of an item and its consumption or demand rate (10:24). For a non-profit organization such as the OSIA, product qualities cannot be quantified in terms of profitability. Instead the measurement is more subjective and is put in terms of an item's critical value to the effective functioning of the organization. Consumption or demand rates are still applicable in assessing product qualities for non-profit organizations. Two analytical methods, "ABC Analysis" and "Critical Value Analysis (CVA)" used together are useful tools in focusing on the most important inventory items (17:183).

Stock and Lambert state that ABC analysis is one of several techniques that can be used to improve inventory management (78:419). ABC analysis is based on a nearly 300 hundred-year-old principle formulated by an Italian scholar.

> In the 18th century, Villefredo Pareto, in a study of the distribution of wealth in Milan, found that 20 percent of the people controlled 80 percent of the wealth. This logic of the few having the greatest importance and the many having little importance has been broadened to include many situations and is termed the "Pareto Principle." This is true in our everyday lives (most of the decisions we make are relatively unimportant but a few shape our future) and is certainly true for inventory systems (where a few items account for the bulk of our investment). (13:605)

The implication of ABC analysis for inventory policy is that about 20 percent of the line items stocked in a warehouse probably account for nearly 80 percent of the volume of requisitions by customers (78:420). The first step is to select some criterion. The use of unit volume (demanded) and value is a common practice. The second step is to rank inventory items according to the criterion. The final step would be to segregate items into three categories: "A" for the highest volume items and "B" and "C" for lower volume items. There are no simple techniques to use for the last step, making it very difficult to accomplish (17:183).

> To a large extent the decision is somewhat arbitrary, requiring a subjective judgement on the part of the decision maker. As one examines the rankings of items, significant natural breaks often will be discovered. But in other instances this is not the case, and a decision will have to be made based on the cost of the control system and the importance of the item. (17:183)

One method for determining the importance of an item is "Critical Value Analysis." The unavailability of a "C" items such as bolts or some other small part which were classified that way under ABC analysis because of low usage may force the shut down of a sophisticated monitoring system. Therefore there is a need to further classify inventory items. CVA does that by the assignment of point values for three to five categories. Coyle, Bardi and Langley gave this example:

1. Top priority: no stockouts - critical item
2. High priority: essential but limited stockouts permitted
3. Medium priority: necessary, but occasional stockouts permitted
4. Low priority: desirable, but stockouts allowed

CVA is a more subjective approach than ABC analysis. But it can be made more consistent and objective if a survey is taken of inventory line items to decide which ones are vital according to established criterion. These items would be given an "A" classification identical to "A" items identified under ABC analysis (17:184).

A logistics system should provide rapid and consistent service on fast-moving items and those slow-moving items that are critical to mission accomplishment. Therefore, consumption rates and mission requirements must be considered together when developing a selective inventory policy using tools such as ABC analysis (10:24). Total logistics costs can be lowered by holding non-critical, slow-moving items at a centralized warehouse, using premium transportation and advanced order processing systems to move the items once they are ordered by a customers. According to Stock and Lambert, an inventory control tool such as ABC analysis "is a method for deciding which items should be considered for centralized warehousing" (78:420).

The final factor to be considered in formulating inventory policy is transportation costs. The more inventory that is held in a logistics system, the lower the transportation cost is per unit of inventory (84).

> Selection of a product assortment to be stocked at a specific facility will have a direct impact on transportation cost. Most transportation rates are based on shipment size. Thus, it may be sound inventory policy to stock more items at a specific facility to generate larger-volume shipments. The corresponding savings in unit transportation cost may more than offset the increase in unit inventory holding [carrying] cost. (10:24)

Another component of a distribution system to be discussed is order management. As mentioned earlier, a customer order [requisition] triggers a distribution system into action and represents the beginning of a performance cycle called the order cycle (10:43-44; 78:499). The "brain" of the distribution system is the order processing system. It is the bridge over which communication about a requisition flows between the customer and the distribution system. Along with transportation, it links the components of a distribution system, providing the information required to efficiently and effectively process an order. A distribution system is only as effective and efficient as its order processing system and the management of that system (17:492).

The final component of a distribution system is warehousing. It concerns the "nodes" of a distribution network, places where products are held for varying periods of time until they are delivered to customers. Stock and Lambert stated that warehousing is the logistics system component where space is managed to hold or maintain inventories. Regarding the holding of inventory, they said, "Generally, the greater the time lag between production and consumption, the larger the level or amount of inventory required (78:16-17).

Important roles played by warehousing within a logistics system include transportation consolidation, mixing, service, contingencies and smoothing (17:250). Roles that would be applicable in a distribution system serving INF or START facilities in the Soviet Union would be transport consolidation, mixing, service and contingencies.

Warehousing aids transport consolidation. Warehouses often serve as collection points for small shipments from different vendors located a short distance away. The shipments are consolidated into a large shipment for onward movement to final destination at a significantly lower per unit transportation cost. A related function to consolidation is "mixing." This occurs when a warehouse receives orders from several customers for products from different vendors. The warehouse receives the vendor shipments, breaks them down, and then "mixes" product items from each vendor shipment to fill individual customer orders. The orders are then shipped to final destination. Another function is "service" which is the time utility that warehousing creates by holding goods reasonably close to a customer so that they are available at or near the time they are demanded. The last function is the protection warehousing offers against "contingencies" of the logistics pipeline, including transportation delays, stockouts by vendors and other disruptions in supply (17:250-252).

An important aspect of warehousing that is closely related to the facility structure component discussed earlier is warehouse site selection. "Whether facilities are owned, leased, or rented," according to Stock and Lambert, the their location is extremely important. The strategic placement of facilities can improve customer service levels (mission readiness) and lower per unit transportation costs (78:17). Other factors to consider when locating warehouses is where the sources of supply are; the transportation services available at the location (intermodal links); labor rates; taxes; legal concerns; local factors; and availability of utilities (78:17).

A subcategory within warehousing is "materials handling," which is concerned with "every aspect of the movement or flow of inventory goods within . . . a warehouse." According to Stock and Lambert, the objectives of materials handling include (1) to eliminate handling wherever possible; (2) to minimize travel distance; (3) to provide uniform flow free of bottlenecks; and (4) to minimize losses from waste, breakage, spoilage and theft (78:17).

> A firm incurs costs every time an item is handled. Since handling generally adds no value to a product, these operations should be kept to a minimum. For items with low unit value, the proportion of material handling costs to total product cost can be significant (78:17)

Materials handling impacts the overall effectiveness of the distribution system. It "contributes markedly to efficient operation" of the logistics system, especially transportation, warehousing and packaging (17:307).

> . . . One very important role of materials handling in particular is to allow transferability between the link and node in the logistics system. Materials handling and packaging contribute not only to efficient operation of the node in a logistics system but also to the efficiency of the link portion of the logistics system. (17:286)

<u>The U.S. National Defense Transportation System</u>

This section will review the Defense Transportation System (DTS) of the United States, which is one of two logistical links used by the OSIA between its Votkinsk portal facility and OSIA facilities in West Germany and the United States. The review primarily examines those segments of the DTS directly supporting movement of goods and personnel to and from Votkinsk. Those segments are the Military Airlift Command and the Military Traffic Management Command. Before those commands are discussed, a short overview of the DTS and the U.S. national transportation system will be given.

DTS Description. The DTS is a DoD-controlled system of five transportation modes which link "the suppliers and users of military weapon systems" (40:6-1). Within that system, three DoD transportation component commands (TCCs) from the Army, Air Force and Navy work in concert with commercial transportation companies in the movement of personnel, equipment and materiel in support of U.S. national security strategy. The TCCs are the Military Traffic Management Command (MTMC), the Military Airlift Command (MAC) and the Military Sealift Command (MSC) (84).

> ... While maintaining a command relationship with each of their respective services, the TOAs [TCCs] exercise single manager responsibilities for various phases of defense transportation. MAC and MSC are primarily transportation mode operators, where MTMC is primarily a traffic manager. Finally, each is industrially funded; that is, the shipper pays for the transportation and/or services obtained from each TOA [TCC] ... (40:6-14)

Commercial transportation firms are an integral part of the DTS and are part of a larger system: the "National Transportation System" (NTS) of the United States. This system "consists of all U.S. firms engaged in the production of transportation services in one of the five modes of transportation: air, sea, road, rail and pipeline" (84).

Figure 4 on this page illustrates the relationship between the DTS and the NTS.

Besides playing a significant role in support of the DTS, the national transportation system of the United States is

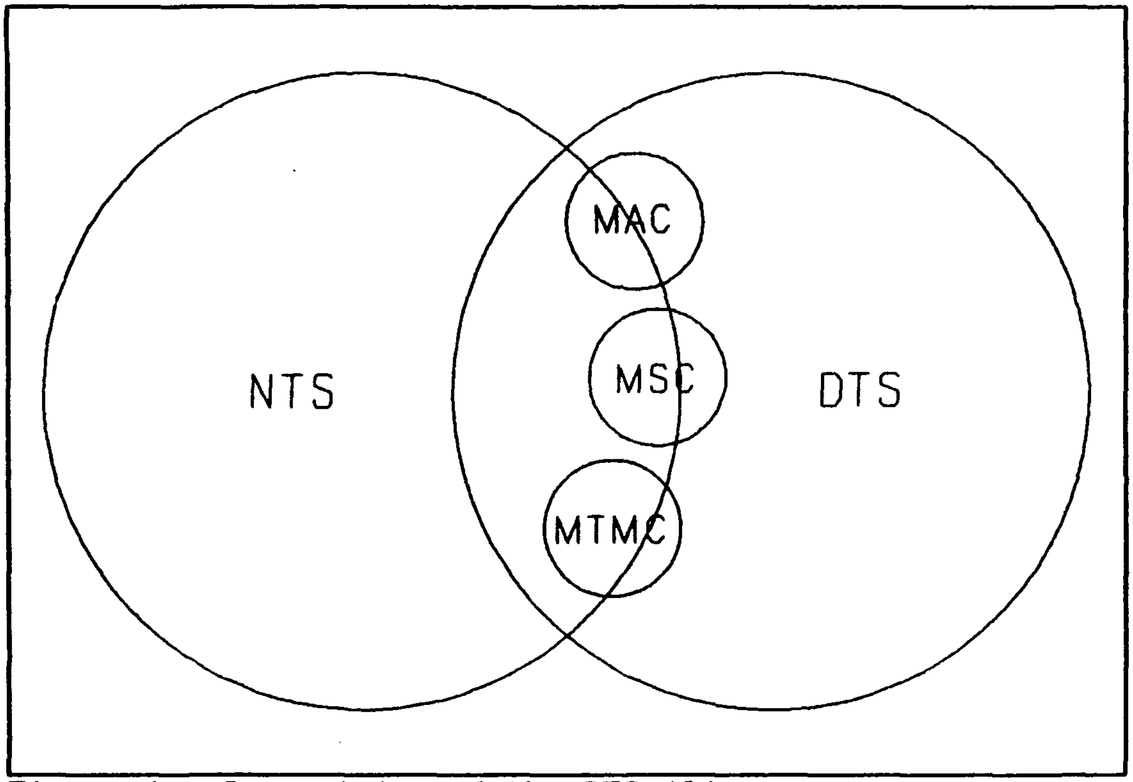

Figure 4. Composition of the DTS (84)

an important segment of the national economy. The five transportation modes accounted for nearly 20 percent of the gross national product over the last two decades (40:6-3).

Pros and Cons of Air, Motor Transport. Because of the high value, time sensitive, and sometimes fragile characteristics of the freight shipments between the Votkinsk Portal Monitoring Facility and supporting depot activities in West Germany and the United States, only air and motor transport support have been used.

Air transport offers speed of delivery as an advantage for distances over 500 miles. In addition, loss and damages associated with air transport are the lowest of all transportation modes (40:6-4). However, there are several drawbacks. The primary one is that of relative high cost. As a result, the types of freight most suitable for air shipment are high value, perishable or emergency in nature. Another drawback is capacity. Aircraft often are "cubed out" -- cabin space is used up by bulky items -- before their payload weight capacities are reached. Another problem is accessibility. There are fewer air freight terminals than motor freight terminals because the network of airports capable of handling large aircraft is much smaller than the network of roads that can handle the typical tractor trailer. When cargo processing times and frequency of service is factored in, it is often more expeditious to move freight via motor carrier for distances less than 500 miles (40:6-5).

Motor carrier transport is well-suited for manufactured and perishable goods. The per unit cost for motor freight transport , relatively low -- much more so than for air freight and, in some instances, quite competitive with rail for some goods at certain distances. Capacity of these transport vehicles is better than aircraft but less so than for rail and ship. The incidence of lost and damaged freight for motor carriers is one of the lowest in the transportation industry, with only air transport having a better record. Rail and marine transport normally have the highest damage rates in the industry. The relative speed of motor transport from the loading dock of the consignor to the doorstep of the consignee is usually unsurpassed for distances less than 500 miles. Relative to other transport modes, this advantage is due mainly to motor transport's relative speed -- second only to air -- and accessibility to both consignors and consignees (40:6-4,6-5).

Military Airlift Command. The On-Site Inspection Agency has primarily depended on MAC aircraft to transport inspectors, equipment and supplies between the West and the Soviet Union. Rueckert states that MAC has been a key player in DoD's success in implementing the provisions of the INF Treaty (71:13). A closer look at MAC provides some insights into its successful support of the treaty. According to Matz, if MAC were a commercial airline, it would be the largest of all U.S. air carriers. The command has 43 different types of aircraft totalling more than 1450 aircraft and about 2950 crews, and operates from 98 locations around the world (56). In addition to its three prime aircraft -- the C-130, the C-141B and the C-5 -- MAC augments its airlift capability through the use of commercial aircraft. In FY 88, 45.1 percent of MAC's revenue traffic was carried by civilian aircraft (56).

As stated earlier, MAC depends primarily on three types of aircraft for its organic lift capacity. For support of the INF treaty, the C-141B and C-5 have most often been used. There are more than 230 C-141B aircraft in the MAC inventory. Each can be configured to carry all passengers, all cargo, or a mixture of both. Configured with airline seats, the aircraft can carry 125 passengers and at least two pallets of baggage. For cargo missions, the aircraft can carry 13 pallets of freight weighing 68,725 pounds total. It's range with this payload is 2,160 nautical miles. For missions between West Germany and Moscow, the aircraft are dual configured, and can carry about 36 to 48 passengers and seven to eight pallets of cargo (57:9-10).

The C-5 has been used by the On-Site Inspection Agency for the three-phased deployment of equipment and initial supplies for the Votkinsk facility. The aircraft were used for missions from Albuquerque, N.M., to Moscow, where the equipment was transloaded to Soviet aircraft. The C-5 is one of the largest aircraft in the world. It can carry 73 passengers and as much as 291,000 pounds of cargo 828 nautical miles without refueling. With mid-air refueling capability, this range can be extended. The aircraft's gross takeoff weight is 769,000 pounds. The dimensional limits for equipment that can be transported by the aircraft are 156 inches high, 216 inches wide and 1,454 inches long (61:23).

MAC aircraft and MAC-chartered commercial aircraft fly two different types of missions in the movement of personnel and equipment in support of DoD agencies. They are channel missions and Special Assignment Airlift Missions (SAAMs). Both types have been used in support of the INF Treaty.

The Airlift Operations School, operated by MAC at Scott AFB, Il, defines channel airlift as:

> Cargo or passengers moved on a scheduled basis between points where the requirements can be both forecasted and are recurring. This is similar to scheduled commercial airline service. (41:204-1)

There are two types of MAC channels. The first is "requirements," and the second is "frequency." A requirements channel is established if the traffic moving between a pair of origin and destination points meets volume criteria established by the DoD. The volume of traffic determines the frequency of service between the two points. The frequency of service is adjusted periodically based on historical data after the channel is established. A frequency channel is established if it can be justified that the mission is needed to support operational readiness, mission sensitivity, morale, or facilities located in remote areas. Aircraft flying frequency channels move on a scheduled basis "regardless of the traffic generated" (41:204-1,204-2).

While the OSIA has used requirements channel airlift to move cargo to Germany from the United States, the agency has relied primarily on SAAM missions since there is no MAC channel between Germany and the U.S.S.R. Harvey defines SAAM airlift as follows:

> The airlift service provided for exclusive use of an agency to meet special consideration of pick up, delivery, classification, off-route requirements, or other validating factors that preclude the use of channel airlift. (41:204-3)

Cost/Service Tradeoffs. It is often much more economical for a MAC customer to move its cargo on a channel mission rather than by SAAM. In some instances, the cost per pound for a planeload (C-141) of cargo could be nearly twice as high for a SAAM mission as it is for moving the cargo on a channel mission (83:1-2). For a SAAM, a "customer" organization "leases" an entire MAC aircraft and crew (with ground support). In return for exclusive use of the aircraft, the customer pays a tariff for the mission itself and the cost of flying the aircraft to the pick up point and, after the mission is completed, back to its basing point (41:204-4).

While it is cheaper to move cargo on a channel mission, MAC cannot guarantee in most instances that a customer's cargo will move together. Also, cargo moves on the basis of "first in, first out" within a four-level priority system established by the DoD. So, there could be some delays in movement (41:204-3).

Military Traffic Management Command. According to Gourdin, Trempe and McCauley, MTMC is DoD's manager for transportation. The command provides traffic management and transportability engineering support to all the services in addition to the "operation of common-user ocean terminals and transportation." As the DoD traffic manager, MTMC is responsible for managing all freight and passenger movements in the continental United States. It also oversees the world-wide movement and storage of personal property belonging to DoD employees and military personnel (40:6-15).

> In contrast to MAC and MSC, MTMC serves as the interface between defense shippers, and commercial and defense carriers. In essence, MTMC marries the traffic requirements identified by defense shippers with the capability managed by carriers. MTMC also monitors the nation's transportation infrastructure to ensure it meets DoD needs; and it studies weapon systems to ensure transportability (40:6-15)

OSIA has relied on motor carriers to move freight from Kirtland AFB, N.M., and from Hickory, N.C., to aerial ports at Tinker AFB, OK., and Dover AFB, DE., for onward movement to Votkinsk. Most of the surface shipments were more than 10,000 pounds or of truckload volume. Shipments of this size, or shipments requiring specialized transport equipment such as tank trailers, must be routed by MTMC if they are being moved under a government bill of lading (20:31).

MTMC exercises overall management control over movement of DoD freight traffic by motor carriers in several ways. It determines proper freight classification, rates, charges, rules, and regulations. It negotiates with for-hire carriers and maintains information on applicable line haul charges; accessorial freight services; freight classifications, descriptions and ratings on DoD freight traffic (20:20). It controls use of motor carriers by DoD activities and authorized government contractors by approving all voluntary and negotiated rate tenders submitted by for-hire motor carriers. DoD activities and contractors can only use tenders which contain a unique MTMC distribution number (20:12).

MTMC also provides technical advice and support to DoD activities and contractors. It has a freight rate quoting service available for DoD agencies and government contractors to assist them in traffic management planning and other duties (20:26). It also provides transportability engineering services to DoD activities to help them assure that new systems are transportable on different modes of transportation -- both commercial and military.

The Soviet National Transportation System

Literature on the transportation system of the Soviet Union will be reviewed. Several terms must be defined in order to better understand the discussion of the literature. The terms are **fixed-wing air transport, intermodal, rail spur, rolling stock, traffic, transportation system, and volume of freight**. A glossary of terms is at the end of this section.

The purpose of this review is to gather information on the Soviet Transportation System -- the second transportation link in the logistics network supporting the Votkinsk facility -- to aid logistics planning for U.S. portal perimeter facilities in the Soviet Union. The information will help identify the type of packaging, containerization and transportability design needed to help assure material is easy to handle and rugged enough to withstand the rigors of both the U.S. and Soviet transport systems. Another purpose is to discover any incompatibilities between the two transportation systems and the possible impacts on cargo preparation and the movement of goods and personnel.

This review will not look at all components of the Soviet transportation system. It will only address domestic fixed-wing air transportation, rail transportation and road transportation. International air and sea transport along with helicopter, river and pipeline transportation will not be examined. The scope of the review is limited because of an agreement in the Intermediate Nuclear Forces (INF) treaty that stipulates each side is responsible for transporting its own material and personnel to points of entry in the other nation. From the points of entry, the host nation will provide needed transportation services. For U.S. activities under the INF treaty, the points of entry into the Soviet Union are Moscow in the western part of the country and Ulan Ude in the east.

A special note must be made about the review of literature on the Soviet air transport system. There is not an extensive amount of published material on the efficiency and operation of the system. Articles tend to give only snapshots or indications of how the system works. In one of the few books dedicated primarily to the study of the Soviet transportation system, Leslie Symons wrote:

> Any attempt to assess quantitatively the efficiency of Soviet operations in the sphere of civil aviation is severely limited by the absence of published statistics and the virtual impossibility of extracting any unpublished information from any source in the Soviet Union ... the problem is further bedeviled by the apparent assumption in Soviet government circles that information relating to all aspects of the aviation industry has some military significance and that therefore only a bare minimum ... should be revealed. (79:144)

This review will first look at the overall role transportation is playing in the economic health of the Soviet Union, and then examine the characteristics of the domestic air and rail and highway transportation modes, and how each is either alleviating or exacerbating the economic situation. The characteristics of each mode will also be reviewed.

Transportation and the Economy. The transportation sector plays a key role in any national economy, whether it is a market or command economy. The following excerpt from the Economist sums up the state of the transportation system in the Soviet Union today and the challenge for Gorbachev:

> Of the many problems he faces as he tries to get Russia moving again, one of the most serious is his country's overstretched and antiquated transport system. Can Mr. Gorbachev get Russia to deliver the goods? (70:45)

Despite concerted efforts to bolster the machine building and high tech industries along with agriculture, according to the Economist article, the Soviet leadership cannot break up bottlenecks and improve the efficiency in the way goods, materials and people are moved within the nation.

> All too often, through mishandling or incompetence, goods fail to arrive: 40% of the tomato crop and millions of tons of coal are lost or wasted each year. (70:45)

Robert S. Dudney, in an article for the Air Force Magazine, made similar observations about the Soviet transportation system. Citing a report to Congress, he wrote "neglect of transport and storage facilities results in the loss of 20 to 30% of the annual wheat crop before it gets to the mill." Another instance he reported was the fact that Soviet medical personnel launder and reuse bandages and syringes because of "inadequate production and distribution of medical supplies" (23:40). Dudney said the biggest problem with food availability in the USSR is the "lack of agricultural infrastructure." He concluded: "Roads, storage facilities, and transport vehicles are dilapidated or non-existent" (23:45-46).

The Soviet national transportation system, as with the entire Soviet economy, is centrally controlled. In theory, planners should be able to coordinate the operations of all transport modes, with the result being an optimized transportation system serving the needs of the national economy. However, empirical evidence indicates that the enormity of that system has at best made central planning very difficult and effective coordination next to impossible (76:3). The central planning of the Soviet transportation system is based upon "branch administrations radiating out from the center. The five modes of transportation -- air, sea, road, inland waterway, and pipeline -- are controlled by different ministries. Shaw states that like most other segments of the Soviet economy and public sector, cooperation between the transport ministries "is often difficult to secure." Because the Soviet governmental system emphasizes vertical rather than horizontal linkages, transportation ministries tend to ignore or minimize intermodal relationships (76:4).

> The charge of departmentalism (vedomstvennost) -- of forgetting horizontal linkages and of putting the interests of one's own department first -- is frequently levied against transportation agencies and is cited as one of the factors militating against optimization in the system (76:4)

Shaw said one result is that often parts of the transportation system are working beyond capacity while other alternative modes are underutilized. Shaw gave examples of how the railroads are often over-utilized while waterways are underused. The perception of branch ministries is that railroads are faster and more reliable, even though it would be more economical to use the waterways. The problem is especially acute in western Siberia where the Trans-Siberia Railroad is overburdened. The Ministry of the Timber Industry could achieve cost savings by using the water system, thus relieving some of the burden on the railroad. But the ministry is reluctant to use the waterways. Another problem is that the ministry would have to ship timber using three waterway authorities which cannot agree with each other over access rights (76:4).

Shaw qualifies his statement on bureaucratic infighting and bungling by stating that the planning system itself is to blame. Transportation ministries are hard-pressed to carry out or modify their plans while meeting other responsibilities. As a result, "there is little time or incentive" to cooperate with other transport ministries on innovations to improve the productivity of the transport system or improve economies (76:5).

Another aspect of departmentalism is that transport ministries are encouraged to give priority to cargo that is cheaper and easier to haul, and to select routes (usually the longer ones to boost their ton-kilometer statistics) which best fit their parochial interests. This helps assure better performance reports. Shaw states that this problem as well as an over-reliance on fixed capital could be remedied by market pricing.

> Although some use is made of economic levers in transportation, administered prices are by no means the same as scarcity prices. The prevailing system is in effect one of rationing, in which enterprises are inclined to exaggerate their transportation needs, knowing that their demands will inevitably be pared down, and in a sellers' market transportation agencies are able to order their affairs to suit themselves rather than their clients. (76:6)

The situation is further exacerbated by there being little incentive for transport ministries to invest in new infrastructure. According to Shaw, transportation ministries tend to be "materially indifferent to the further expansion of their networks." Instead, the incentive is to invest in reconstruction projects. The result is that managers tend to opt for a quick fix by increasing the use of the existing infrastructure, diminishing the system's capability to absorb shocks to the system and seasonal surges in traffic (76:6-7).

One problem with Soviet investment policy is that there are no market mechanisms to guide investment decisions. It is very difficult to conduct cost-benefit analyses of alternative investments to select the most cost effective transport mode to invest in. A good example of this problem is road transport.

> In the U.S.S.R. road transport plays second fiddle to railways, especially for long distance freight movements, and investment in roads at the local level is often dispersed among numerous agencies. The road system, in consequence, is poorly developed. (76:8)

Shaw concludes that Soviet transportation problems go beyond departmentalism. He said that even if it were eradicated, it would be replaced by some other phenomenon. such as localism. He believes the Soviets will have to make more fundamental reforms to turn around their transportation system.

> The real faults are overcentralization and lack of incentive and competition. Not until these things are put right can much progress be hoped for, and there is little prospect at the moment for such a radical change in course. (76:20)

Intermodal Comparison. Nearly 13 billion tons of freight were hauled by transport carriers in the Soviet Union in 1989, down nearly two percent from 1988. More than half of that total was carried by motor carriers, mostly between freight terminals of other transportation modes and freight consignees/consignors. Rail was ranked second in terms of tonnage at 4 billion tons and pipelines transported 1.2 billions tons of freight. The average distance a ton of freight was hauled in 1989 for all transport modes was approximately 379 miles, which was a 9 percent increase from 1988. Total passenger-kilometers was 1,128 billion. Railroad travel accounted for nearly a third of that total followed by air travel at 228.9 billion passenger-kilometers (35:117).

Fixed-Wing Air Transport. The Soviet Union stretches across eight time zones and spans two continents. According to Victor L. Mote, an associate professor of Geography and Russian Studies at the University of Houston, "almost all of Russian and Soviet history can be characterized as a struggle to overcome the friction of distance." He went on to say "Soviet planners and engineers have taken pride that the struggle has been ameliorated with modern technology and socialist planning" (62:13). Today, that challenge is being met best by aircraft and, in particular, by Aeroflot, the Soviet national airline (the only airline in the nation), according to Harriet Fast Scott.

> Aeroflot may be lacking in comfort, but the train ride on the Trans-Siberian Express from Moscow to Khabarovsk in the (Soviet) Far East is nearly seven days. There are no roads in somc places. Aeroflot gets you there in eight hours. No wonder flying has become the major mode of transportation in many areas of the country. (75:54)

Scott said that by 1965 the Soviets claimed Aeroflot was the largest airline in the world with the second largest volume of passengers. "By 1969, air became the main means of transporting passengers in the Far East, Central Asia and the far north. Air transportation connected more than 3500 cities and towns in the USSR" (75:57).

Symons makes this observation about the role of air transportation in the Soviet Union and the infrastructure required:

> At over 22,400 million square kilometers, the Soviet state is by far the largest in the world. Inevitably, it includes vast areas of thinly populated terrain, negative because of climate and relief, which can support only the most skeletal of ground transport services, so that the burden of supplying them falls to a very large extent on the airlines. This requires the provision of a vast number of airfields which are relatively thinly used and therefore expensive to maintain, together with the ancillary services such as navigational aids, fuel transport and engineering support necessary to operate over these territories. (79:147)

In 1987, Aeroflot logged 204.2 billion passenger-kilometers as compared to 645.1 billion passenger-kilometers flown by all U.S. airlines that year. Aeroflot is also one of the world's largest freight carriers, flying 3,410 billion ton-kilometers in 1987. This is compared to 14,167 billion revenue ton-kilometers flown by all U.S. airlines the same year (12:196-197).

The percentage of national freight traffic carried by Aeroflot continues to grow, but it is still dwarfed by the amount carried by the railroads. The airline carried more than 3.3 million tons of cargo and mail in 1989, however it still represented less than one percent of the freight tonnage carried by the nation's rail system (34:56).

Despite its small piece of the freight traffic pie, the airline does play a key role in the distribution of economic goods -- especially food. The airline is actively engaged in transporting foodstuffs aboard cargo aircraft to many remote areas of the Soviet Union, cut off from service by other transportation modes because of geography, climate and economics (59:25). Aeroflot also is a key transportation link in the unofficial economy.

> Much of the fresh produce sold on the open market in Moscow, Leningrad and other northern cities arrives in suitcases carried from (Soviet) Georgia aboard Aeroflot by enterprising gardeners. They still make a tidy profit after paying for their round-trip tickets. (75:53)

Like many western airlines, Aeroflot augments the airlift capability of the Soviet Union's air force, which has 600 fixed-wing transports (74:61)

> The transport aircraft of the Soviet airline, Aeroflot, with its 1600 medium- and long-range transports, should also be included as a fulltime reserve of this component. (74:61)

However, it appears the relationship between Aeroflot and the Soviet Air Force is changing. Reports from the Soviet Union in the past 18 months indicate that the Soviet Air Force now augments Aeroflot's airlift capability. An announcement was carried by the TASS news service in April 1989 which stated that the USSR Council of Ministers had approved the use of Military Transport Aviation (VTA) aircraft in the movement of consumer and industrial products (58:93). While VTA aircraft are apparently hauling cargo nationwide, they are being used especially to carry foodstuffs to settlements and cities in the northern and eastern regions of the nation (59:25). These areas are isolated with few of them serviced by railroads or paved highways. Airlift is often the only means of resupply for much of the year, and has heavily tasked Aeroflot aircraft.

> Every day they fly dozens of runs to ... towns in the north. Over the course of a hauling season more than 40,000 tons of "vitamin product" is hauled north from our southern regions. Thanks to these efforts the workers in the Arctic and remote Far Eastern regions receive fresh fruits and vegetables practically at the same time as Muscovites, Leningraders, and other people in our country's central regions. (59:25)

According to an article which appeared in the Aviatsiya I Kosmonavtikia in August 89, which was written by Avn A. Volkov, the U.S.S.R. Minister of Civil Aviation, Aeroflot was not able to meet "agricultural hauling requirements" of 65,000 tons for 1989. A shortfall in capacity of 25,000 tons was going to be made up by Soviet Air Force transport aircraft. He blamed the shortfall on shortages of fuel, aircraft and aircraft engines.

In an article which appeared in Krasnaya Zvezda in May of 1989, Colonel General Avn V. Yefanov, commander of the VTA, said that approximately 60 military transports would rment Aeroflot operations and would carry about 50,000 tc "national economic cargo" in 1989. He said the VTA would charge other ministries for the airlift support, and 30 percent "of the profit" would be used to improve living conditions for VTA personnel and their families (60:63).

Two aircraft are at the core of the Soviet Union's increasing airlift capability. They are the Antonov An-124 "Condor" and the Illyushin IL-76 "Candid-B." They are, respectively, the Soviet counterparts to the United States' C-5 Galaxy and C-141B Starlifter. The An-124 is the second largest aircraft currently flying (in terms of wingspan) and has one of the heaviest maximum takeoff weight of any aircraft ever built (81:83-84). By mid-1987 both Aeroflot and the Soviet Air Force were operating a combined fleet of 10 aircraft with planned production of eight to ten aircraft per year (81:83-84). Taylor said the aircraft can carry the largest Soviet battle tank or giant earthmovers and can operate on surfaces as austere as frozen tundra or ice-covered swampland (81:84). The IL-76 can operate on similar surfaces and is the workhorse of the Soviet Air Force air transports, comprising 60% of the fleet (81:84). It can carry 140 passengers or 40 metric tons of cargo, according to Taylor. Both aircraft have self-contained cargo handling systems (81:83-84).

The ability of the Soviet airlift system to haul outsize cargo was further enhanced this past year when the An-225 Mriya was introduced to the world at the 1989 Paris Airshow. The six-engined airlifter is the largest in the world in terms of size and takeoff weight. It has a wingspan of 287 feet, is 273 feet long, and the height of its tail section is nearly 59 feet. The aircraft has a maximum takeoff weight of 600 metric tons, compared to 405 metric tons for the An-124. The An-225 is longer than the An-124, and can takeoff with 250 metric tons of cargo aboard, which is approximately 100 more metric tons than the An-124. The An-225 can carry 200 metric tons of cargo more than 2700 miles without refueling. Its on-board cargo handling capabilities are typical of Soviet cargo aircraft, but it can handle heavier pieces of cargo. An overhead crane mounted on a rail in the aircraft cabin can lift individual pieces of freight or containerized freight weighing up to 20 metric tons. The aircraft also has winches rated at more than 50 metric tons capacity for the loading and unloading of vehicles and wheeled equipment (4:79-84).

Available data indicates Soviet passenger and cargo aircraft can accommodate a wide range of different cargoes, from small packages to earth movers and other pieces of outsized equipment. The maximum size of a piece of freight that can be carried in the belly compartments of the three leading Soviet Passenger aircraft -- the IL-86, IL-62M and the TU-154 -- is 48 inches high by 52.4 inches wide. The IL-86 can handle pieces of freight as large as 99.2 inches high by 70 inches wide. See Figure 5 below. Since Aeroflot services more than 3500 hundred airports in the Soviet Union, it appears the airline can offer adequate overnight

Luggage Compartment Dimension Data

Type of Aircraft	Max Size of Cargo Hatches (in)		Tot Volume of Compartment (cubic ft)
	Ht	Wth	
IL-86	99.2	70.0	407.1
Il-62M	50.4	52.4	157.6
TU-154	48.0	54.0	141.1

Figure 5. Soviet Passenger Aircraft (11:10)

or next day freight service. However, there are indications that Soviet passenger aircraft are underutilized as freight carriers, especially for overnight packages and time sensitive freight shipments.

> Central planning of postal and newspaper flights also appears to conflict with regional planning. Thus, daily flights from Khabarovsk to Magadan were said to be carrying 20-30 passengers, giving ample room for up to five tons of freight but this was being sent on a separate postal/freight service. In two weeks the Magadan Aviapredpriyatiye carried 124.5 tons of freight less than the plan required, thereby wasting crew time, flying hours and fuel, which, it was argued

from Magadan, could all be remedied by cancelling the postal flight. (79:159).

Soviet cargo aircraft can handle a variety of freight. The workhorse of the Aeroflot aircraft fleet, the IL-76, can handle three 20-foot ISO containers or seven U.S. Air Force 463L pallets. The maximum height of cargo that can be handled on the IL-76 is 124 inches (11:7-8,10). See Figure 6 below.

Cargo Compartment Data

Characteristic	An-12	An-22	An-124	An-225	IL-76
Length (ft) of Cargo Compart	42.6	95.2	118.2	141.1	65.6
Max Ht. of Cargo (in)	90.6	173.3	173.3	173.3	124.1
Max Wth of Cargo (in)	82.7	173.3	252.1	252.1	128.0
Max Tot Vol (Cubic Ft)	2117	-----	-----	-----	6351
Max Tot Wt (Metric Tons)	20	80	150	250	40

Figure 6. Soviet Cargo Aircraft (11:7-10)

Little is known about the efficiency of the Aeroflot airlift system in handling cargo quickly and safely. Indications are that much of the domestic system relies on manual means for uploading and downloading freight and baggage from aircraft and for transloading betweenaircraft and ground transport vehicles. Symons commented that along with other problems in the Aeroflot infrastructure, especially the supply of engines and spare parts, there appears to weaknesses in ground services support.

> Less sensational, but recognized as essential for high productivity, the mechanization of passenger and freight handling and organization of airport services (including cleaning), provision of containers and loading and handling equipment, are all items that stimulate criticism. One complainant named Tyumen, Kharkov, and Sverdlovsk as important airports that lacked container - handling equipment. (79:160)

More is known about the main freight terminal at Moscow International Airport, Sheremetyevo-2. The facility is a near state of the art facility built by the West German construction company, Phillip Holtzman, located in Frankfurt. The facility was built in conjunction with a major international arrivals terminal for the 1980 Moscow Olympics. In 1989, Aeroflot reported that the terminal handles an average of 150,000 tons of cargo and plans to expand its capacity. It now serves as an intermediate stop and break bulk point for the airlift of containerized cargo between Japan and Western Europe on what the Soviets call the "Trans-Siberian Trunk Route." It is a mixed air-sea route with modal interface points at Yokohama, Japan, and Nakhodka and Vladivostok, U.S.S.R. The cargo is moved in 20-foot International Standardization Organization (ISO) containers aboard Il-76 aircraft, which can carry three of the containers. Average transit time is between 10 and 14 days (11:1-6).

The freight terminal has automated facilities to handle containers and pallets directly from aircraft (11:7). Il-76 cargo transports are backed up to tracks leading from high-line docks which extend out from the terminal. A pallet/container loader vehicle traverses the tracks between the high-line dock and the aircraft, shuttling unitized cargo loads. Inside the terminal there are automated container and pallet handling facilities.

The freight facility does have at least one elevator loader for pallets and containers that can operate independently from the tracks to service aircraft parked on ramps. The piece of equipment was used to handle single pallets of cargo from Military Airlift Command aircraft during the deployment of equipment and supplies for the Votkinsk portal monitoring facility (82:4). Outdoor, all-weather forklifts capable of handling U.S. Air Force aircraft cargo pallets were not in evidence at the airport. It appears that a common practice is to use self-propelled cranes in conjunction with cargo handling systems aboard aircraft to download and upload heavy pieces of freight from Aeroflot cargo aircraft.

The Izhevsk Airport near the Votkinsk Portal Facility does not have mechanized cargo handling capability. Soviet and American cargo aircraft using the airport are serviced by cranes brought in from the local economy. During January 1989, at least ten Military Airlift Command C-141B aircraft airlifted in equipment to the airport direct from Rhein Main

Air Base. A group of Air Force personnel with a 25K aircraft loader and a 13K all terrain forklift were flown in to handle the cargo from the aircraft (25; 73:1-4).

There was another instance where Soviet cargo handling capabilities were not adequate to efficiently download unitized and outsize cargo from U.S. aircraft. Over a period of several months in 1988, seven C-5A missions were flown to Semipalatinsk in the central Asia region of the country. On board the aircraft were more than one million pounds of American-made equipment used to monitor the yield of underground nuclear weapon explosions by the Soviets as part of the Joint Verification Experiment (JVE) between the U.S. and the Soviet Union. Instead of relying on the Soviets, the U.S. flew in a special team of Air Force personnel and materials handling equipment to download the cargo (14:1-3).

Railroad System. In 1984 the system carried nearly half of the freight volume within the Soviet Union and nearly four times as much as the sealift system which was ranked second behind it (70:45). It is one of the busiest rail systems in the world, according to Major General John G. Murray, USA (Ret), who toured the Soviet Union in 1987 with a group of U.S. railroad officials.

> The first thing you don't see on Russian railroads is rust on the tracks. Russian railroads handle over half the railroad freight traffic and a quarter of all the railroad passenger traffic in the world. It is a saturated system. (63:22)

The infrastructure of the U.S. rail system is nearly twice the size of that of the Soviet Union, but the amount of freight carried by U.S. trains in 1985 amounted to a little less than a third of that carried by Soviet railroads (63:22). In terms of tons-kilometers, Soviet railroads logged 3,924 billion in 1988 compared to 1,474 for U.S. railroads. Actual tons carried for Soviet railroads in 1988 was 4,116 million metric tons compared to 1,793 metric tons carried by U.S. railroads (12:190-191).

According to Ambler, Hunter and Westwood, the Soviet railway system carries 55 percent of the world's freight traffic and 25 percent of its passenger traffic. "At any one time, 40 million tons of various commodities are somewhere on the rail system," they reported. Hunter gave this assessment of the types of freight being carried by Soviet railroads:

> The demand for rail freight transport in the U.S.S.R. is dominated by the need to move primary commodities: fuels, ores, construction materials, etc. The most important single commodity group is coal (including coke), followed by crude oil and petroleum products. Most Soviet crude oil now moves by pipeline, but the railroads still carry a large volume of refined products. An equally large group, "mineral building materials," includes cement, bricks, stone, sand, gravel, etc. Timber, both sawn and unsawn, is reported separately and still plays a large role in the U.S.S.R. The other major commodity groups for which annual data are regularly reported are iron, and steel products, ores, grain (including flour), and fertilizer. Manufactured goods are buried in a residual "other freight" category, which as a whole accounted in 1983 for only 18 percent of rail tons originated. (48:5)

However, the performance of the railway system began to ebb in the late 1970s and early 1980s. One reason is that heavy use of the system and mismanagement by top rail officials have eroded the infrastructure of the system. "Much of the rolling stock is out of date and falling to pieces. Vast trains drawn by several locomotives damage the older lines" (70:46). Troubles with the Soviet rail system cited by the Economist are supported by an article which appeared in the journal, Problems of Communism. The rail system had annual gains in freight volume until about 1978, and then little or no growth in volume for the next four years (52: 24). However, for at least ten years leading up to that period, growth could not be attributed to stronger or additional track being laid, or new locomotives and rail cars capable of hauling heavier goods at faster speeds. Instead the system was saturated --most of its excess capacity used up -- by running more trains on each route (52:22-24).

> Thus, by the end of the 1970's, on almost one-third of the lines of the railway system (handling the major part of the freight volume), the capacity utilization rate reached 80-90%. On long stretches of double-tracked line carrying a significant share of total traffic, the average interval between trains headed in the same direction was approximately ten minutes. The capacity of stations and classification yards was similarly strained. While a railroad capacity utilization rate higher than 75% is physically possible, and can be attained for short periods of time, it is not sustainable. A system simply will not have enough capacity in reserve to compensate for unforseen stresses, such as might be brought on by poor weather conditions and breakdown of equipment. (52:24)

Kontorovich reported in the article that by 1978 the rail system had become another bottleneck in the Soviet economic system. On the busy rail lines, anytime there was bad weather or a train broke down, it shocked the system, backing up traffic. Total annual freight volume declined sharply in 1979 and 1982. (52:24-25). The system began to recover in 1983 and 1984, and that by the second quarter of 1985 was showing "a high rate of growth" (52: 26). This growth was attributed to newer and better rolling stock, improvements to the system infrastructure and "wider application of well-known techniques" such as running heavier trains using "double and triple engines, pushing as well as pulling, and electronic synchronization of the operation of several locomotives" (52:27).

Kontorovich never reported whether the system continues to have utilization rates near those that led to a slowdown in growth of the system. But in 1987, American railroad officials riding the Trans-Siberian Railroad, the major east-west rail line in the Soviet Union, observed "westbound freights every 10-20 minutes, with each train consisting of 50-60 cars" (63:22).

While the Trans-Siberian has such features as overhead cranes for handling of shipping containers used in transportation systems throughout the western world as well as other components such as electronic switches, it lacked many features common to railroads in Europe and North America (63:22). First, there were no rail spurs off the mainline to support industry. Second, there were no intermodal warehouses capable of handling trucks on one side and trains on the other. Also not evident are forklifts, pallets and other common materials handling equipment found in western freight warehouses (63:22). Also, flatbed and refrigeration cars are "in short supply," according to Murray.

> Those (refrigeration cars) that exist operate in clusters of five. The middle car has a cupula with a worker manually controlling temperatures in all the cars. (63:22)

Road System. The weakest mode in the Soviet Union's transportation system is the intercity road system. "It is the Soviet rural roadway system that confronts Russia with a crisis of truly awesome proportions" (23:46). The Economist reports that "only two out of every five Soviet villages are served by paved roads" (70:45). In his article, Dudney cited the following statistics provided by the Central Intelligence Agency:

> Only 20 percent of the roads used to move farm workers, feed livestock, move machinery to the fields are paved. Some 11 percent of the regional centers and 18 percent of collective and state farms still have no reliable link to the main road system. By contrast, in the U.S., nearly all farms are linked to paved roads. In the Russian Republic, the most advanced farm area, only one-eighth of the rural roads have hard surfaces. (23:46)

The reports in Dudney's article are supported by an article that appeared in the Summer 1987 edition of Studies in Comparative Communism. "With twice the area of the United States, the Soviet Union's roads equal only one-third of U.S. road length and much of it cannot be used in bad weather" (15:167). As a consequence, truck freight volume (tons per kilometers) in the USSR is minute compared to the volume/distance statistics of long-haul trucks in the United States. As an example, in 1987 motor carriers in the United States logged 1,084 billion metric ton-kilometers as compared to 491 billion metric ton-kilometers for Soviet truckers (12:192). The freight volume of the Soviet trucking industry in 1982 was only seven percent of total freight tonnage (15:167).

> Although trucks in the total economy deliver more tonnage than railroads, their average length of haul is short, only 18 kilometers, in contrast to 434 kilometers by river boat and 930 kilometers by rail. The destination of these brief truck trips is more often to other transport -- rail and water trans-shipment centers -- rather than to final users. (15:167)

Crouch made a similar observation when comparing surface transportation modes to each other, noting that intercity freight transport by truck was still in its "infancy" in the Soviet Union when compared to the role motor carriage plays in western Europe and North America. He blamed the situation on "bad roads, high costs and administrative problems (18:166) While motor transport represents a small proportion of the ton-kilometers of freight moved in the country, it plays a fairly large role in some sectors of the economy, according to Crouch.

> Much of the output of the consumer goods industries, one third of the country's grain, 40-45 million tons of the sugar beet and many other farm products are transported annually by motor vehicle. (18:166)

A closer look at motor transport in the Soviet Union shows that most of the tonnage is carried by private fleets while common carriers move a small fraction of intra and intercity tonnage (18:167). Ambler stated that in 1983 private fleets accounted for 70.8 percent of the total tonnage moved by motor transport. According to Ambler, Soviet authorities are trying to expand common carriage and to reduce private fleets in an effort to make more efficient use of the nation's transportation resources. However, he said the efforts have failed. For an eight year period ending in 1983, private fleets grew at a 7.5 percent annual rate while common carrier fleets grew at a 6 percent annual growth rate (2:14).

Crouch makes a distinction that freight transport by truck should never be called road transport. Instead, it should be referred to as "motor transport." His point is based on the relative lack of paved roads in the country. He stated: "... a lot of motor transport does not take place on the roads but on farm tracks, across open country and on winter ice and snow or in quarries and mines." According to Crouch, off-road transport of freight "can be assumed" to be a significant portion of the total motor freight tonnage hauled in the Soviet Union (18:165-166).

There is a considerable amount of variation from region to region in the degree of roadlessness. As measured by kilometers of paved roads per 1000 hectares of developed agricultural land, the Baltic republics and the Transcaucus region have the most developed networks of paved roads. The Russian Republic (the largest republic in the Soviet Union where Moscow is situated), Central Asia and Siberia have the least developed network of paved roads (18:170). See Table I on the next page.

Crouch states that ironically for most regions winter is the best season for motor freight traffic because frozen rivers can be crossed and otherwise impassable off-road areas are firmed up by frost, ice and snow. Spring poses particular problems as most travelled areas turn to mires of mud or are flooded. Summer can pose problems as even the best roads can crack, crumble or melt from intense heat (18:170).

Another problem with freight transport in the Soviet Union is an inadequate stock of transport vehicles, especially specialized transport vehicles. While the country tripled its output of trucks between 1966 and 1975, the production of such vehicles are not necessarily meeting the requirements for efficient and effective motor transport. Two-and-half ton and five ton GAZ and Zil trucks, which are "robustly constructed," are the most common types of trucks in the Soviet Union. But, these vehicles are inefficient to operate. according to Crouch, because they are heavy and underpowered. The two-and-half ton trucks made up 81 percent of the vehicle stock in 1981. In contrast, large capacity vehicles of more than five tons made up less than 10 percent of the tota. vehicle stock. Crouch states that "optimal fleet distribution figures nationally" required that the fleet of large capacity

Table I. Paved Roads in the Soviet Union (18:170)

Kilometers of Paved Roads Per 1000 Hectares of Farm Land

Republic	KM	Republic	KM
Estonia	16.50	Moldavia	3.76
Georgia	8.67	Tadzhikistan	3.30
Latvia	6.76	Uzbekistan	2.31
Lithuania	5.66	Russian Rep.	1.91
Armenia	5.46	Kirgizia	1.74
Azerbaydzhan	4.84	Kazakhstan	0.39
Ukraine	3.93	Turkmenistan	0.37
Belorussia	3.82		

vehicles make up 30 percent of the national vehicle stock (18:173).

The disparity between requirements and actual production is even more acute for specialized transport vehicles. Crouch said there are chronic shortages of vans and light trucks, cross-country vehicles of all types and refrigerated trucks (18:172).

> Although seven different refrigerated truck models are built, production of all models is well below target at present. There is no large refrigerated truck (over 5 tons) available at all. Gosplan, while aware of the problem, appears undecided as between road or rail refrigeration, but meanwhile much of the fruit harvest, for example, is lost annually because of this situation: 'at present in places horses and carts are doing the job refrigerated truck transport should be doing.' (18:172)

There are indications that larger capacity trucks are now being produced. Three new types of trucks are being produced with capacities ranging between 18 and 30 tons (91:189).

Another problem with the highway system is the timeliness of handling freight at truck terminals and warehouses. A rule of thumb in transportation is that a parked transport vehicle is not making money. Clayton relates that in the Soviet Union there are many "parked" vehicles. "One estimate indicates that an average truck experiences 40 days demurrage (waiting time) each year" (15:173). The reason for this is materials handling equipment is scarce and most freight handling is done by hand. Inadequate warehouse space is also a cause of the problem (15:173).

In conclusion, most of the Soviet transportation system is aged and only marginally productive. It is often a bottleneck in the production and distribution of goods in the Soviet Union. However, it appears the system is fully able to move people efficiently. The most glaring economic impact cited in the articles is on food supply. Food shortages in the Soviet Union result more from inefficiencies in the nation's distribution infrastructure than from poor soil or farming techniques. However, many other industries are also affected.

An intercity highway system and line-haul freight trucking common in most of Europe and North America is practically non-existent in the USSR. As a result, it appears that U.S. sites within the Soviet Union operating in support of arms reduction treaties will have to depend on air and rail transport for their logistical pipeline. The airline system is the USSR is vast and appears to connect most cities and towns. It would probably become the preferred transportation mode for sensitive equipment and perishable foodstuffs required at the U.S. sites. The rail system, although aging and congested, moves most of the freight volume in the country. The system appears to be recovering from a major crisis earlier this decade when saturation of the system by too many trains resulted in several system "shocks" similar to grid locks experienced in large American cities. New management techniques and an infusion of capital appear to have turned the situation around. Finally, it appears the transportation system has a major inefficiency at terminals and warehouses. Materials handling equipment appears to be scarce, and cargo on transport vehicles is often handled by hand.

Glossary of Terms. The following are definitions of several transportation terms used in this section.

1. **Fixed-wing Air Transportation** - All transport aircraft that can't be classified as helicopters.

2. **Intermodal** - Capable of being transported on more than one transportation system.

3. **Rail Spur** - A short section of railroad track extending from a main rail line much like a driveway from a road. Its purpose is to allow the loading and unloading of rail cars at a facility such as a warehouse.

4. **Rolling Stock** - Wheeled equipment such as vehicles, trailers, locomotives, or rail cars.

5. **Transportation System** - A means of moving people and goods from one point to another.

6. **Volume of Freight** - Statistical measurement of the capability of a transport system in terms of weight carried per unit of distance, i.e., 1000 ton-miles or 1000 ton-km.

Elements of Integrated Logistics Support

This section will review literature on Integrated Logistics Support (ILS) and the ten basic elements of ILS. The purpose of the section is to provide an overview of the ILS elements and build a framework for presenting and analyzing logistics lessons learned from the acquisition, deployment and operation of the Votkinsk Portal Monitoring Facility. Those lessons learned will be presented in the next chapter. Using the ILS elements as a framework is applicable because ILS for a system such as the one at Votkinsk "does not end until a system is retired from the inventory." As Materna and Andrews state, ". . . the process of planning and implementing logistics support will continually evolve" (55:5-4)

Integrated Logistics Support is described as:

> A disciplined, unified and iterative approach to the management and technical activities necessary to:
> a. Integrate support considerations into system and equipment design.
> b. Develop support requirements that are related consistently to readiness objectives, to design, and to each other.
> c. Acquire the required support.
> d. Provide the support during the operational phase at minimum cost. (19:2-2)

Materna and Andrews state that the key to ILS is that each of the ten ILS elements are interrelated. Any change in one could greatly affect the requirements of another.

The process of integrated logistics support should be managed as a single entity and not as a collection of unrelated functions (55:5-3).

Once a weapon system is deployed to the user and management responsibility is transferred from the acquisition organization, "the logistics support structure devised" gets a shake-down test. Materna and Andrews state that it would be unrealistic to expect that every facet of a logistics support system is going to perform as planned or meet real world requirements.

> With this as an accepted given, follow-on actions must be pursued to correct deficiencies . . . Thus, ILS planning does not end until a system is retired from the inventory. So, the process of planning and implementing logistics support will continually evolve. (55:5-4)

In order to make ILS more manageable by dividing logistics support into functional areas, the DoD has categorized logistics support into ten basic areas. Each of the services has augmented the core list with several additional elements (55:5-4). Lessons learned from Votkinsk will be categorized using the basic DoD list, which is contained in the Department of Defense Directive (DODD) 5000.39. They are (1) Maintenance Planning, (2) Manpower and Personnel, (3) Supply Support, (4) Support Equipment, (5) Technical Data, (6) Training and Training Support, (7) Computer Resources Support, (8) Facilities, (9) Packaging, Handling and Transportation, and (10) Design Interface.

Before each element is briefly described, it must be remembered that not all the ILS elements apply to each and every weapon system during its acquisition, deployment and operation. Every system has different requirements. It must be determined what elements are necessary (55:5-3).

The following descriptions of the ten basic ILS elements are excerpts from Materna and Anderson's discussion of ILS elements.

> 1. Maintenance Planning: This process establishes maintenance concepts and requirements for the life of the system. It includes, but is not limited to, levels of repair; repair times; testability requirements; support equipment needs; manpower skills; facilities; interservice, organic and contractor mix of repair responsibilities; site activation; and so forth ... It is this very element that establishes the baseline for planning, development, and acquisition of other logistics support elements.
>
> 2. Manpower and Personnel: This element involves the identification and acquisition of military and civilian personnel with the skills and grades required to operate, maintain, and support systems over their lifetimes. Early identification is essential.
>
> 3. Supply Support: This element consists of all management actions, procedures, and techniques necessary to determine requirements to acquire, catalogue, receive, store, transfer, issue and dispose of spares, repair parts, and supplies. In layman terms, this means having the right spares, repair parts, and supplies available in the right quantities, at the right place, at the right time. This process includes provisioning for initial support, as well as acquiring, distributing, and replenishing inventories.
>
> 4. Support Equipment: This element is made up of all equipment (mobile or fixed) required to support the operation and maintenance of a system. This includes ground handling and maintenance equipment, tools, metrology and calibration equipment, and manual and automatic test equipment

. . . Much of the SE used today is a repairable item itself and, therefore, requires the timely development and fielding of a logistics support system for the SE as well . . . if the support equipment isn't available because it cannot be repaired, the availability of the prime mission equipment could be affected.

5. Technical Data: This element represents recorded information, regardless of form or character (such as manuals and drawings), of scientific or technical nature. Computer programs and related software are not technical data; documentation of computer programs and related software is. Technical orders (TOs) and engineering drawings are the most expensive, and probably the most important data acquisitions made in support of a system. Without them, it may be difficult, if not impossible, to operate and/or maintain the prime system and support equipment. Also crucial to a systems LCC [Life Cycle Cost] is engineering drawings. They allow competitive reprocurement of spare and repair parts and the modification of systems, which, in the long run, should minimize the system's LCC.

6. Training and Training Support: This element consists of the processes, procedures, techniques, training devices, and equipment used to train civilian and military personnel to operate and support a system. This includes individual and crew training, new equipment training, initial, formal and on-the-job training . . . The less than optimum training of system operators and maintainers could degrade mission effectiveness and decrease system availability.

7. Computer Resources Support (CRS): This element encompasses the facilities, hardware, software, documentation, manpower, and personnel needed to operate and support mission critical computer hardware/software systems . . . The expense associated with the design and maintenance of software programs is so high that one cannot afford to not manage this process effectively . . . As can be seen in its definition, this element does cross the lines of responsibility in other ILS elements (i.e., facilities, manpower, etc.)

8. Facilities: This element consists of the permanent and semipermanent real property assets required to support a system, including studies to define the type of facilities or facility

improvements, location, space needs, environmental requirements, and equipment . . . the absence of the necessary capabilities within a facility, or the absence of the facility itself, will be adversely felt by the prime system the facilities are intended to support.

9. Packaging, Handling, Storage and Transportation (P,H,S,&T): This element is the combination of resources, processes, procedures, design considerations, and methods to ensure that all system, equipment, and support items are preserved, packaged, handled, and transported properly, including environmental considerations, equipment preservation for short and long storage, and transportability . . . P,H,S,&T may be a somewhat overlooked element, but it is not inexpensive. The reliability of a component can be significantly influenced by how it is packaged, what type of handling equipment and procedures are used, where and how it is stored and the mode of transportation used to get it from the vendor to the eventual user. Transportability, on the other hand, means designing into a system or an item the ability to be transported . . . Transportability requirement decisions must be made early in the system acquisition process and thoroughly delineated in the system specifications.

10. Design Interface: This is the relationship of logistics-related design parameters to readiness and support resource requirements. The logistics-related design parameters include (a) reliability and maintainability, (b) human factors, (c) system safety, (d) survivability and vulnerability, (e) hazardous material management, (f) standardization and interoperability, (g) energy management, (h) corrosion, (i) nondestructive inspection, and (j) transportability. These logistics-related design parameters relate to system readiness objectives and support costs of the system. Design interface really boils down to evaluating all facets of an acquisition (from design to support) and operational concepts for logistical impacts to the system itself and the logistic infrastructure. (55:5-5-5-8)

Summary

This chapter presented information to help understand the distribution networks which now -- or may in the future --

support operations of U.S. arms control facilities in the Soviet Union. It also presented a framework which will be used in the next chapter for understanding logistics lessons learned from support of the Votkinsk Portal Monitoring Facility. The chapter began with a look at integrated logistics management, and the similarities and dissimilarities in logistics management between business firms and non-profit organizations such as the military. A case was made that the concept of integrated logistics management was applicable to both businesses and the military. Then an overview was given of the concept, which is a systems approacn to moving and storing material at the least total cost to meet organizational goals. That was followed by a review of the aspects of least-total-cost network design.

Then literature was reviewed on the two transportation systems linking OSIA facilities in the distribution network supporting the Votkinsk Portal Monitoring System: the U.S. Defense Transportation System and the Soviet national transportation system. The final section of the chapter presented an overview of the concept of Integrated Logistics Support (ILS) and the ten basis elements of ILS. Those elements will serve as a framework in the next chapter for the presentation of logistics lessons learned from support of the Votkinsk portal facility.

IV. Analysis

This chapter presents an analysis of information gathered from the literature review in Chapter Three and from personal and telephone interviews conducted with government officials, businessmen, and contractor personnel supporting the Votkinsk facility. The chapter is divided into four sections, with each section helping to answer one of the four research questions posed in chapter one.

Logistics Lessons Learned

While there are many lessons to be learned from the implementation of the INF Treaty, this section focuses primarily on logistics lessons learned as they apply to portal monitoring facilities. The lessons learned are categorized according to the basic elements of Integrated Logistics Support which were presented in the last chapter. Based on answers to interview questions, not all the ILS elements could be used as part of the framework for presenting lessons learned. Also, several of the experts interviewed gave "planning" as one of the most important lessons learned. It did not necessarily fit the framework for the presentation, although planning is an integral part of the ILS concept that applies to nearly all the basic elements. Therefore, it is discussed separately outside the basic framework of this section.

Maintenance Planning. Perhaps the most important lesson learned in this area is that more maintenance planning should have been done for support equipment or what HTSC managers call "life support equipment." This includes kitchen equipment, laundry equipment, and office equipment. Office equipment includes such items as personal computer systems, copiers, and shredders. Jim Saunders, HTSC program manager for the Votkinsk Portal Monitoring Facility, said his company had to adjust the focus of its maintenance planning for support of the facility.

> Initially we were gearing most of our maintenance planning toward prime mission equipment, not realizing there was a lot of life support equipment involved in this performance -- and that's generally where we are probably seeing more maintenance activity than anywhere else. We would basically look, in future development, to pay more attention to the life support stuff that is going to have to be maintained in the long run. At this point we have had very few failures in the prime mission arena. The majority of our failures have been the kitchen, the ice making machine, the stoves, the refrigerators, things of that nature. You kind of tend to place more emphasis on your prime mission equipment to do the treaty verification aspects. Whereas, if the stove broke, the guys couldn't cook or eat, so then you have a real problem on your hands. Those are the areas we will pay more attention to next time around. (72)

U.S. Army Lieutenant Colonel Roy Peterson, a site commander at the Votkinsk facility, stated that the site cannot depend on the local economy to provide appliance and office equipment repair services. Local purchase of such services is not an option. He agreed with Saunders that Hughes technicians will have to be adept at trouble shooting support equipment as well as prime mission equipment. Based on lessons he has learned, Peterson recommends that maintenance planning for START portal and perimeter monitoring facilities include manning sites with technicians more capable of maintaining support equipment in addition to prime mission equipment.

> I'd like to see technicians stay on site who fix things such as the copier machine, which has gone down on occasion; who can oil and fix the shredding machine. I'm talking about relatively simple machines. But, you can imagine the more complex machines of the continuous monitoring system and how you need to have technicians available on hand to repair these because if something fails we don't have a second chance. In the case of CargoScan, we have to be able to repair it immediately within a four-hour period of time by the MOA. If we can't do that, then we lose the right to image that missile basically. (67)

Peterson stated that there should be a cadre of highly skilled maintenance technicians on call at some location in western Europe who would be able to respond expeditiously to perform corrective maintenance at sites. He said the maintenance technicians could deploy into the Soviet Union with what they believe are the needed repair parts based on communications with site technicians. He said this would greatly improve customer service levels and lower total logistics costs. Current procedures call for highly skilled technicians to deploy from the United States after a sometimes lengthy process of pre-clearance with the Soviet government (67).

Manpower and Personnel. Another lesson learned is that civilian contract personnel have proved to be highly effective in terms of cost and performance in providing operations and logistics support. With the treaty imposing a ceiling of thirty inspection personnel who can man a continuous monitoring facility, there is a premium on personnel who are multi-skilled specialists.

Contractor personnel are being used instead of military personnel because of a Joint Chiefs of Staff decision made before the treaty was ratified. The JCS chose not to make a long-term commitment to man the site with DoD personnel because of the specialized nature of the work and the fact that the skills needed would require the creation of new military specialty codes, placing yet another demand on military technical training centers (50). The JCS was looking at as many as 400 people who would have to be trained to man as many as six sites under initial planning for implementing the INF Treaty, according to Gene Johnston, a retired Air Force lieutenant colonel who worked in Verification Policy in the Office of the Under Secretary of Defense for Policy. He now works for the Arms Control and Disarmament Agency (ACDA) on the Special Verification Commission.

Johnston said the JCS decided that each site would have a cadre of military officers directing contractor personnel who would operate and maintain the site.

VPMF site commanders have been pleased with contractor performance because of the wide range of skills that they can bring to the job of operating and supporting the site.

> They (Hughes Technical Services Company site personnel) have a lot of technical expertise that we would have to try to scrape up from the various military services and put together and send over there. That is not always very easy to do. Part of the continuous monitoring function could be done by Army, Navy or Air Force personnel. But, the great advantages are, number one, that this (expertise) exists in the civilian world and it's easy to procure, and, number two, we do not have to fight for those resources from the various armed services that are undergoing constraints in the budgetary process and draw down. (67)

Saunders said the advantage of going with contract personnel is the cost effectiveness. The military can forego the additional overhead expense of a support system to train personnel, he said. According to Saunders, it would not be feasible for DoD to man the sites with its own personnel unless there were requirements for "thousands of people" to be trained (72).

While he was satisfied about how well manning the site has worked out, Saunders stated there was a problem during the initial deployment because of the treaty-imposed ceiling of 30 personnel allowed on site.

> I think we had a pretty good handle going in on the types of manpower and personnel required. One of the disadvantages I saw was the requirement to do an installation and operational maintenance at the same time. Generally speaking, you would be talking about two different categories of people with different mentalities. So, we had to come up with a crossfeed where we weren't necessarily efficient in both areas, but we basically got the job done. In the future I would like to basically see maybe the treaty allow for installation

> personnel and O&M personnel. But, I would at least like to see the number of personnel doing the initial deployment be higher than what you would have for an O&M phase. (72)

Saunders recommends that during the deployment and installation of the START portal facilities the personnel ceiling be waived to allow 40 to 45 Americans so that installation specialists can be on site at the same time as operations specialists.

Supply Support. The one problem most often mentioned by VPMF commanders and the facility's contractor is the resupply of the site. OSIA policy is to purchase consumables such as food as close as possible to the point of consumption (30). However, in terms of quality and quantity of goods and services, the local economy in the Votkinsk area cannot adequately support the facility. Purchases in Votkinsk have been meager -- mostly bread and a few vegetables -- and OSIA officials quickly recognized that they would have to contend with the same problem as most Soviet consumers: shortages of food and consumer products. The lesson learned is that the logistics pipeline supporting the site will be long. The facility will have to import these items from the U.S. military supply system and commercial sources in West Germany -- and sometimes from the U.S.

Perhaps part of the problem is the Soviet Union does not have a developed national economy. Instead it is a loose system of regional economies. Other than energy and mineral resources, grains and some timber products, very few products are distributed nationally (64). If an item is not manufactured or produced in a region, more than likely it will not generally be available. According to George A. Gecowets, who toured areas of the Soviet Union in 1987 with several other U.S. business people as members of the Council of Logistics Management, there does not appear to be a national distribution system in the country. He said that any western business looking to do business in the Soviet Union will probably have to set up its own distribution system because there are no public warehouses, wholesalers, freight forwarders and intermodal transportation networks (38).

Navy Commander Chuck Myers, another site commander at Votkinsk, made a similar observation about the distribution and availability of consumer goods in the country. He said the quality and availability of goods at "any particular time" can vary considerably, and this fact must be planned for in supporting the site.

> Of course they have concrete. Of course they have lumber. Can they get you everything you need right now? Not necessarily! One thing that we noticed that was quite interesting, although I guess it's not news, the Soviet economy is not only autarchic to a large extent with regard to other countries, but it's locally autarchic within the country. Most of what is consumed in the Udmurt Autonomous Soviet Socialist Republic is produced in the Udmurt Autonomous Soviet Socialist Republic. If the fact that they have something in Moscow or Kharkov, or in Minsk or somewhere else does you absolutely no good if you're in Votkinsk. They can't get it in from Moscow. It has to be available from where you are, and to be available from where you are, it almost has to be produced from somewhere not too far away. There are

> exceptions to that, of course. But if you need concrete, for example, okay, they'll allocate you some of their supply of concrete. But they can't get anymore. You can't just pay a premium to get more of it. They might take the premium, but they still can't get any more concrete. (64)

McDonald's Restaurants of Canada, which earlier this year opened the first of 20 stores planned in Moscow after nearly 12 years of negotiations with the Soviet government, has set up its own supply and distribution network. All dairy, meat and agricultural produce are sourced within the Moscow region and processed at the Moscow-McDonald's Food Production and Distribution Center located in the Moscow suburb of Solntsevo, according to Rem Langan, Director of Marketing for Moscow-McDonald's (54).

Langan said McDonald's agricultural experts are working with farm cooperatives in the Moscow area to assure high quality produce. The company has also had to introduce the Russet Burbank potato and Iceberg lettuce to the farms because the vegetables are not native to the Soviet Union. McDonald's has also assisted in the harvesting of crops (69:2).

McDonald's-Moscow's distribution system is practically self-contained. At its production and distribution center, McDonald's produces all the ingredients used for products served in McDonald's Moscow store. Refrigeration trucks -- scarce in the Soviet Union -- have been imported from West Germany and move product ingredients and condiments from the distribution facility to the store (54). Langan said

McDonald's is looking to expand to other Soviet cities. Saying he was not a distribution expert, Langan declined to answer whether or not McDonald's would have to set up its own national distribution system or adopt a system where each market would have its own production and distribution center similar to McDonald's-Moscow. He did say the Moscow production facility could handle some additional demand (54).

Articles in Soviet trade and economic journals as well as programs aired in the broadcast media indicate that most ministerial departments and other government organizations have their own agricultural, transportation and distribution infrastructure to support their workers. The Soviet Army, for one, has its own farms. And Aeroflot, railroads and other large organizations feed, house and equip their workers (35:89).

U.S. government organizations are faced with the same logistical problems. The U.S. embassy primarily supports itself by importing much of what it consumes from Finland. Stockman's, both a retailer and wholesale distributor of food, business and consumer goods based in Helsinki, supplies the embassy and its personnel and dependents with most of what they use. The material is trucked to Moscow on one of the few good roads in the Soviet Union -- a two-lane highway stretching about 500 miles between the two capitals. But the products are expensive and there is some lead time (36).

For the Votkinsk portal facility, resupply is even more of a challenge. After testing several alternatives, OSIA officials have concluded the portal facility will have to be supplied by airlift from western Europe.

The initial plan at Votkinsk was to purchase food as close as possible to the point of consumption in order to avoid transportation costs and damage from handling, according to U.S. Army Colonel Douglas Englund, Chief of Staff of the On-Site Inspection Agency and a former site commander.

> As a rule out in Votkinsk, we would buy what was available. That turns out to be not very much. We would buy bread. We would buy eggs, but Soviet eggs suffer from a problem common to Europe where there is a high possibility that they may be infected by salmonella. So, we were kind of constrained in how we cooked them. And whatever vegetables were available during that time. First of all, the Soviets have a very low selection, and, second of all, it's very seasonal. We'd get carrots when we could get carrots; we'd get cabbage occasionally; we bought most of our potatoes in the Soviet Union. But again you can get a hundred pounds or so of them but the thing is you'd have a lot of spoilage, and they may be smaller than you would like. (30)

The next step was to order food wholesale from a Soviet government organization in Moscow called Vneshposyltorg, which loosely translated means the organization for dealing with foreigners. It is a prime supplier of food to foreign embassies located in Moscow. Vneshposyltorg was eager to serve the Votkinsk site according to Englund, but could not overcome distribution problems to deliver food to Votkinsk. A food order placed on 13 December 1988 with the agency was not delivered to the site until 25 March 1989. Only ten of twenty items requested were delivered. Another order placed in April of 1989 took 40 days to deliver with less than a third of the order filled. The shipment also contained seven items the site did not order. On 23 June 1989, a third attempt to use the agency was made. The results were better. The order was delivered in two weeks but only half of it was filled. (16:10). Englund summed up the difficulties the OSIA had with shipments of food from the Soviets.

> We had some deliveries. But it was never fairly successful because it's also hard to organize anything in the Soviet Union. They would deliver things that should have been refrigerated to an area airport and then it would be lost and everything spoiled. So, they had to do it all over again! They wouldn't have things that we ordered. They would substitute chewing gum for -- this is not a truthful example but a literate example -- for cookies. (30)

The OSIA finally resorted to airlifting perishables from the Air Force commissary at Rhein Main Air Base in West Germany. Inspectors rotating in to the site every three weeks bring in about 6000 to 8000 pounds of food and supplies to the site. Bulk orders of dry goods are brought in twice a year, according to the site's Integrated Support Plan (9:55). Colonel Englund stated that until a better solution can be found, the food pipeline supporting Votkinsk will be long and relatively expensive to operate. Myers sums up the situation facing logisticians in the resupply of the Votkinsk portal.

> Going into this, we were aware that it's difficult to get things in the Soviet Union, and it's difficult to get them <u>into</u> the Soviet Union.

> We've validated that several times. The Soviets are limited in what they can provide to us, certainly in terms of quality and in terms of goods that we are familiar with, and any sort of technical stuff for the system, they simply would not be able to provide it. We have made attempts to obtain what we can from Soviet sources. We do obtain some things. We'd like to do more of it, but even when the Soviets show great eagerness to provide stuff, only for a few things are they really reliable suppliers so that we have been in the business -- perhaps more than we have preferred -- of flying stuff into the country. (64).

Another lesson learned under "Supply Support" concerns communications links used to track equipment and supplies. Mike Embree, the logistics manager for the HTSC program office, stated that Hughes had originally looked at using a personal computer network linked by modems as part of an inventory control system. The system would allow the main logistical database at the program office in Manhattan Beach to be updated automatically with each inventory transaction at Votkinsk and other facilities in the logistics network supporting Votkinsk.

But the quality of telephone service available within the Soviet Union has prevented HTSC from using the PC-modem network to provide a real time link between facilities in the logistical network. As a result, the database at the program office in Manhattan Beach is updated only after the warehouse at Votkinsk dispatches updated computer floppy disks with inspectors rotating back to West Germany. The problem is not impacting the processing of requisition orders, but it is hampering inventory control, particularly the tracking of assets in the warehouse at Votkinsk.

> I am required to ship assets and have them acknowledge receipt for those items so I can close out the whole loop of tracking the assets. So, I have to wait a relatively long time to close out all the loops. I can't see what is really going on. If someone calls me and says, 'How many widgits do you have on your shelf,' my records may be showing ten, but in reality it may only be five. But, I won't see that for another three weeks. (28)

Saunders added to Embree's comments about how supply support is being hampered by problems with electronic communications.

> The telephone communications which we are very dependent upon these days to do business is very difficult working within the Soviet Union. Right now there's only two lines running between Votkinsk and the embassy, and they are land lines. With the interface between those lines and the communications back to the States, there's only certain times of the year that it's tolerable. Others times there's no communications whatever. (72)

Technical Data. The portal monitoring system deployed to Votkinsk consisted of major elements from a demonstration system that was developed through the Department of Energy (DOE) by Sandia National Labs in Albuquerque, New Mexico. Its purpose was to show how the United States would conduct portal monitoring at selected Soviet facilities if a nuclear missile treaty between the two superpowers was implemented (50;1). According to Johnston, the development contract was let and managed by the Air Staff at the Pentagon for the Office of the Undersecretary for Defense for Acquisition (OSD/A) with inputs from OSD/Policy (OSD/P) (50).

> Policy set the requirements; Acquisition sent the money to the Air Staff; and the Air Staff actually spent the money through the Air Force. The actual mechanism was the Air Force through the DOE (Department of Energy) to Sandia. (50)

The monitoring system evolved under several different scenarios during its development several years prior to the actual signing of the INF Treaty. Proposed scenarios included one that envisioned the site as a nearly automated facility with only a few technicians actually on site to perform preventative maintenance and limited corrective maintenance (77). Most of the monitoring would actually be done by trained inspectors located in the United States who would use a satellite feed from video and data collection systems at the site. Other scenarios were less high tech, but still involved the use of fairly sophisticated, commercially-available components and subsystems (1). The common theme for all the scenarios was the assumption on the part of planners that there would be very few American inspectors allowed to be continuously based at the site. Therefore, the monitoring system had to be fairly automated. The development work proceeded in the absence of specific user requirements. When the treaty was signed and ratified, both sides had approximately six months to establish monitoring facilities. The short lead time drove the decision to deploy the system at Sandia, even though it was developmental (1). That decision complicated logistics planning because there was very little work done in developing bills of material, drawings and technical data needed for establishing logistics support of the system. This created a need for HTSC to work closely with Sandia to develop the needed database for logistics support of the facility.

> Well, on this particular program we were dependent upon Sandia for the continuous monitoring system. They developed a system with the idea that it wouldn't be deployed, that it was a developmental system so when the decision was made to deploy they were caught short on having developed the needed data. Basically, we have suffered as a result of it. It has basically complicated the installation, operation and maintenance process. I think the way we were able to soften that kind of blow was that we were fortunate enough to have highly skilled technical people/engineers going on and learning the equipment fairly quickly. (72)

According to Embree, there was very little supportability and maintainability built into the continuous monitoring system deployed to Votkinsk, mainly because, as explained above, the system deployed was originally a demonstration system. With a tight deployment schedule dictated by treaty agreements, the monitoring system was turned over to HTSC in a rapid-fire fashion.

> Really, they (Sandia) integrated a lot of parts to make an end item. And it was turned over to us very quickly to meet the shipment schedule. They would give us items and say, 'This is called ...' whatever the nomenclature was used. We took it and put it down on paper as receiving it, just for accountability records, and it went to Votkinsk immediately -- but with no documentation to support what it really was. (28)

Embree said that there were no bills of materials or top down drawings available to help logisticians track what parts were used in a particular assembly -- contrary to most programs which have drawings in place prior to full scale development.

> We got the system, tore it down, packaged it, shipped it to Votkinsk. Then the drawings came later. Well, to track the parts properly we should have had a sound data base or drawings in place. (28)

Embry stated that because the system was developmental, his company had very little information on part numbers, suppliers information, and all that which is normally available on most weapon systems. He said that under the circumstances dictated by the treaty, there was little time to take a coherent approach towards how the monitoring system would be maintained after it was deployed (28).

> Because they (Sandia and DOE) weren't looking at deployment, a lot of these logistics tie-ins were not there. I don't expect that to happen on future deployments because the government has moved in that direction (maintainability) as far as new portal and perimeter monitoring systems. They (DNA and Raytheon Corporation) are going in the direction where they are developing prototypes with the idea that they are going into production, levying upon the developer at the deployment phase to deliver the technical data. (72)

Facilities. As stated in chapter one, Under the terms of the treaty and the Memorandum of Agreement for inspection activities at portal sites, the inspected party, if requested to do so by the inspecting party, will provide housing, work facilities, food, medical care, site preparation, ground work and the provision of such items as water, concrete, lumber, electricity, fuel and an assortment of building supplies. There has also been a learning process in this area for American inspectors.

Embree stated that because of scheduling pressures for the deployment of prime mission and support equipment, a decision was made to ship a sizeable number of electrical equipment that ran on 110V/60HZ power. This forced personnel at the site to rely heavily on electric power transformers to convert local power which is 220V/50HZ. "We learned that's not the way to go. Next time around we need to certainly send the right type of voltage equipment to support the site," he said (28).

Haver stated that having electric equipment that can operate on host nation power without the use of transformers is one of the more important lessons learned.

> Everything that goes in needs to be on host power, run on 220, 50 hertz rather than 110. We found innumerable problems associated with trying to convert from one to the other and back again because we have a mix of equipment currently on site. And at future portals we plan to have nothing but 220 Volt/50HZ. That presents a bit of a problem because we don't sell very much of that in the U.S. therefore we are forced into a lot of foreign purchasing or purchasing from foreign divisions of American companies where possible. (42)

Another lesson learned under facilities is the need to conduct more extensive site surveys before systems are actually deployed. Saunders stated that if there is an operations and maintenance contractor for START facilities, the contractor should be on the survey team (72). He said that HTSC was hampered by the fact that as the primary logistics organization for support of the Votkinsk facility, it was not able to participate in site surveys. He said that if HTSC had been able to, it would have been better prepared to carry out its responsibilities under the contract (72).

> We were dependent on government agencies to provide our data, and we would have approached it a lot differently in terms of getting into the details of what to expect once we got on site. And that would then drive the kinds of logistic support that we would be really able to say we need in order to go into a particular location to minimize the inconvenience of the installation. (72)

Saunders gave an example of the impact on logistics support and the installation of monitoring systems at the site.

> I guess the biggest thing would be in the process we went through in laying cable, putting cable on the ground. Site surveys give you a good feel for exactly what the topology is; what tools are available locally to do it; and a good feel for the attitude of the local Soviet officials that you are going to have to deal with. In planning for that (cable laying), there was a whole gamut of things that you could learn from the contractors point of view that maybe the government did not necessarily pick up. (72)

Haver states that it is important to conduct site surveys to understand what the host nation has available in terms of logistics support and then to determine if that will meet mission and support requirements.

> Logistically, it is important to ensure that all your equipment can be - all your equipment is compatible with the host location. That is, if you are doing some of your own plumbing, the threads have got to be metric interface or you have to have adapters to take it to metric to interface with the local sources. Anything along that line. You have to understand what is available, what you have to interface with, and be able to make the adaptions and have all of that equipment with you when you arrive. (42)

Haver stated that site surveys tie into the need for meticulous planning to ensure that installation operations go smoothly. As part of that planning, he said that any equipment to be deployed for use at a remote site such as Votkinsk must be preassembled and tested before it is ever sent over. Otherwise, "you find that you end up without particular kinds of adapters, etc." (42)

In another lesson learned, Myers noted that American inspectors have found that quality standards for building supplies in the Soviet Union don't match those in the United States. This must be accounted for during logistics planning for START, according to Myers.

> We discovered, for example, that they're not familiar with the concept of non-shrink grout. Their cable conduit is made of asbestos. They don't have any junctions for it, at least not in Votkinsk they don't. They have problems with the quality of wire, electrical wire . . . So, we have had to bring in construction supplies of our own. Sometimes, sorts of things we would not have suspected. We really would have suspected they could make conduit out of something other than asbestos. Wrong! A lot of fasteners are just awful quality. Yes there are good quality ones somewhere in the Soviet Union. They're using the good quality ones in those missiles inside the plant. But, if you go down to the hardware store, you're going to find junk (64).

Myers said that the quality of lumber that is readily available in the Votkinsk area is not very good, looking "suspiciously like split birch logs." He said the site has had to wait for quality.

Several weekly reports cited problems with the quality of Soviet electrical equipment. One report outlined how a series of lights in the facility's warehouse were finally repaired after nearly a year. The problem was due to "bad termination, breakers, and wiring." The same report also dealt with another wiring problem. Appliances in the facility's laundry could only be operated one at a time because of poor quality wiring. According to the report, Soviet wiring "was about the grade of speaker wire and was in danger of causing fires in rooms such as the laundry where there was constant use of high voltage appliances. Instances such as this forced the OSIA to begin replacing Soviet wiring with imported wiring in all housing areas (68:3).

Packaging, Handling, Storage and Transportation. Much has been learned about shipping cargo between the Soviet Union and the United States. Lessons have been learned about how materiel should be palletized, unitized and containerized for transshipment between the U.S. Defense Transportation System and the Soviet national transportation system.

According to one report on the INF Treaty prepared for the Office of Strategy, Arms Control and Compliance at the Pentagon, treaty language was vague regarding the transport of cargo and personnel for continuous monitoring sites.

> Transportation issues involving the movement of heavy portal equipment, inspectors and supplies into and out of the portal monitoring sites were not covered in the INF Treaty and like technical equipment issues required additional efforts to resolve. (71:79)

Also, little was known about Soviet capabilities in handling palletized and containerized cargo loads for U.S. aircraft.

> We learned a great deal about how to ship things in and out of the Soviet Union and how to do the packing and documentation. I think there was a lot of good work and coordination done by ESD and the Hughes people in setting up a system that would work. (30)

U.S. inspectors and equipment are subject to Soviet immigration and customs procedures at the POEs under the treaty. Luggage is x-rayed and inspection equipment is thoroughly examined to ensure that it is allowed under the treaty. If Soviet officials at the POE or portal site believe the equipment is not allowed under the treaty, it is impounded until both sides can agree as to its status (22:47). There were instances where the U.S. had to return some equipment to West Germany.

The Memorandum of Agreement between the two sides stipulates that the inspecting party will give a ten-day notice of the arrival of cargo aircraft carrying freight for its continuous portal monitoring site. The notice, which is similar to a pre-manifest, gives the total weight, pieces and cubic volume of the shipment and information on the largest piece of cargo and any special handling characteristics of the cargo (15:25-26).

According to Englund, a lesson learned is that the Soviet airlift system can handle OSIA cargo unitized on USAF 463L pallets. The pallets, which are 88 inches by 108 inches, have a capacity of 10,000 pounds. Individual pieces of cargo can be stacked up 96 inches high on the pallets.

Another area under PHS&T concerns transportation charges that each nation can levy on the other. According to Reuckert, the INF Treaty is vague regarding which transportation services can be billed and the specific procedures for reimbursement. He said this is a lesson learned (71:47).

Under the treaty, the United States must reimburse the Soviet government for certain expenses for fuel and servicing of MAC aircraft at Moscow, Ulan Ude and at Izhevsk. But there have been disagreements between the two nations. For a ten-month period that ended 1 May 1989, the Soviets are seeking about $1,057,910 for a variety of airport charges in addition to fuel and aircraft servicing; however, the U.S. position is that it owes only $398,133 for fuel and aircraft services (65:Atch 1).

Another expense the U.S. is liable for is transportation of inspectors and equipment between Moscow and Votkinsk. Exact rates are still being worked out, but LTC Gerald Heuer, director of the Resource Management Division at OSIA, said those charges will be about $10,000 for airlift of up to 30 inspectors aboard Aeroflot passenger aircraft and approximately $20,000 for the use of an IL-76 cargo aircraft. The rates are for one-way trips between Moscow and Izhevsk, the closest airport to Votkinsk (45). With rotations of incoming and outgoing inspectors every three weeks and two cargo flights per year, these expenses could amount to about $380,000 per year (the treaty allows each side to rotate its portal inspectors every three weeks).

Design Interface. Under this ILS element, there appeared to be two primary lessons learned. The first was simplicity in the design of monitoring systems, and the second was the transportability of those monitoring systems. Several former and active site commanders, the operations and maintenance contractor and the program manager for the acquisition of START portal monitoring systems all mentioned simplicity and transportability. The site commanders said that the combination of the harsh climate of Votkinsk, its remoteness from sources of supply and the critical nature of the site's mission required that monitoring systems be rugged, dependable, and easy to operate and repair. Colonel Englund stated that the need for simplicity in system design was the most important logistics lesson learned so far from Votkinsk.

> I believe, first and foremost, and I think this is probably something absolutely shared by people in OSIA, that whatever we send out there should be the simplest thing that we can come up with to do the job. I think that Votkinsk was plagued by a system that was considerably over-engineered for the job at hand. We had much more equipment than was required to do that job. Consequently, it dragged out the installation process to, well, virtually a year to get the TOSI system, as it was deployed in Albuquerque, up and running. And, as you know, or may not know, we just X-rayed the first railroad car on the 21st of March (1990). Virtually a year and a half after the equipment was -- after the treaty went into force -- it was

> the first time now yesterday that we can say we have a fully operational site. (30)

Saunders pointed out a specific example of "over-engineering." It involved vehicle and railcar weight monitoring subsystems. He said that based on the actual mission requirements of the site, the system to measure vehicle weights was not required. It was designed to weigh vehicles as they passed over scales embedded in a road that led from the portal of the Votkinsk missile assembly plant. The system would give the payload weight of the vehicle to assist inspectors in verifying that it was not carrying a treaty limited item.

> We came to learn, and this could have been picked up in a good site survey, and I'm sure it was, there is no road traffic coming out of this facility where you really need a weight scale because all the roads there won't support a treaty limited item being transported by vehicle. Everything that comes out (of the assembly plant) that is in the treaty limited category, would be carried by railcar. The general consensus is that we view the Votkinsk site as kind of like a test bed where they were testing all these concepts. (72)

Boren states that his program office's motto for the development of START portal and perimeter monitoring systems is "Keep it simple." This includes the computer-controlled monitoring systems that will be used at START sites. One initiative, according to Boren, is to avoid software as much as possible and rely instead on "hardwired" systems. Beyond the requirement for simplicity, another driver behind this is to avoid "technology transfer problems associated with software" (8).

> The simplicity of design that the Soviets can appreciate and see is simple, and they can appreciate that it's driven by relatively simple hardware systems -- electrical as opposed to computerized. They'll have more confidence in it. (8)

Boren said his office is assuming that START sites will receive very little "state of the art" logistics support.

> Their society and industrial base are a lot further behind than ours. And, consequently, we assume a certain tech base is going to exist, and it's not there. So, from a civil engineering support standpoint, from the reliability of certain utilities and support services that we take for granted in America, we assume they are not going to be there. This further reinforces the idea that you gotta keep it simple and go with a known tech base and don't try to do anything too fancy or elegant.

Another lesson learned in the design interface area is transportability of equipment. Boren, Peterson and Connell referred specifically to the transportability of mobile shelters which are used to house a diesel generator and the Data Control Center (DCC) at Votkinsk. The diesel generator provides backup power to the site and the DCC is the operations center of U.S. inspection and monitoring activities at Votkinsk (47:4-5). The shelters, which are eight-feet high, eight-feet wide by 20-feet long, conform to International Standardization Organization (ISO) specifications and are commonly known as "ISO shelters." The shelters were specially modified by the EG&G Corporation for use at Votkinsk. The modifications, however, changed the transportability and handling characteristics of the shelters, especially how they could be lifted by cranes.

They could no longer be safely lifted from their top four corners and, instead, could only be lifted from their bottom four corners. A device called a "spreader bar" would have to be used to protect against the crane's hoist cables from damaging the side walls of the shelters. This presented a transportability problem because freight handling systems on Soviet cargo aircraft consist of overhead cranes that lift cargo onto the aircraft and to a designated position in the cargo compartment. The overhead clearance between the DCC shelters and the top of the cargo compartment was too small to use a spreader bar. As a result, the Electronic Systems Division, which was managing the acquisition and deployment of the DCC shelter system, had to borrow special dollies from the U.S. Army called "M1022 mobilizers." The mobilizer is a set of four wheels that attach to ISO shelters and basically turn them into trailers (49:1). With the mobilizers, the shelters could be rolled on and off Soviet aircraft (49:1). But the use of the mobilizers cost the government nearly $100,000 as a MAC Special Assignment Airlift Mission had to be used to airlift the mobilizers from Fort Campbell, KY., to Moscow. There was also the additional problem of getting mobilizers out of the Soviet Union and back to Kentucky.

Boren stated that this experience is a lesson learned and one that is being applied in the design of shelter systems to be used for START portal facilities.

> Right off the bat we spent a considerable amount of time with OSIA giving us their perspective of the problem with the Soviets and transporting them and so forth. One of the things they insisted on very strongly is that we design our shelters so that they can be handled by Soviet handling equipment and be transported by Soviet aircraft. And a key lesson learned was that they be handled from the top and not the bottom. That led to the procurement of a specific line of shelters for our deployable systems. (8)

Relating to transportability design, Peterson said another lesson learned is for U.S. logisticians to be aware of the similarities and dissimilarities between transport and cargo handling equipment used in the United States and the Soviet Union -- and how cargo should be configured for shipment.

> The Soviets don't have the same types of forklifts we have -- the same types of capabilities. Sometimes we have had to use k-loaders and other types of things to move equipment about. With some equipment, such as the ISO shelters, we had a real problem . . . The important thing to remember is that the Soviets have a lot of difficulty with some of these things -- and we end up having to handle those things ourselves in the process. So I think those are some of the major logistical lessons that I've learned. (67)

Peterson said equipment and supplies must be containerized so that they are more transportable within the Soviet transportation system. He said that the cargo handling capabilities of Aeroflot, which has transported all OSIA cargo between Moscow and Votkinsk, is quite limited. "Matching our containerization to fit their system is a good way to go in the future." (67)

<u>One Other Lesson Learned</u>. Not all lessons learned fell neatly within the framework of the ten basic elements of

ILS. Several site commanders cited "planning" as a major logistics lesson learned. This lesson was a common thread which ran through several ILS elements, including the most obvious element, "Maintenance Planning." However, there appeared to be an especially close relationship between planning and the "Supply Support" and "PHS&T" ILS elements.

There are several reasons why planning is very important in the logistics support of the site. The primary reason is that the INF Treaty and its associated documents represent for all intents and purposes a legal contract between the United States and the Soviet Union. And, according to officials the On-Site Inspection Agency, the Soviets have been very legalistic in carrying out their obligations under the treaty. This has imposed several restrictions on the movement and use of personnel at Votkinsk and on the movement and storage of equipment, food and materiel needed to operate the facility. Other reasons for careful planning are the harsh weather extremes in the Soviet Union and the isolation of the site from sources of supply.

Both Myers and Haver stated that U.S. inspectors at Votkinsk have learned to look ahead and to deal with long lead times in the delivery of needed supplies. Because the supply of consumer goods in the Soviet economy is so unpredictable, he said that site commanders have to be prepared to ship in from Western Europe "virtually anything" needed at the Votkinsk facility. Haver said that any piece of equipment or item of supply that an inspector anticipates on using, he has to be able to bring it in with him. "We can't expect to find it or a suitable alternative in the Soviet Union or Eastern Bloc as they are structured right now," he said. This situation, along with restrictions on the movement of personnel and materiel, and the types of materiel that can be used at the site, make planning very important.

> Advanced planning is required. There are substantial delays involved in getting things in. Careful thought is also required to how the Soviets will react to what you bring in, especially if it's technical equipment. But, to perhaps a trivial degree, you still have to document things like food. That, and just the mechanics of getting it in, place a very high premium on advanced planning, and anticipating everything that you're going to need, when you're going to buy it, when you're going to have it delivered to the gateway point (Rhein Main, Ge.), when you're going to have the (shipment) documentation ready that the Soviets require, and when you're going to take the items in. (64)

According to Myers, last-minute additions of equipment and supplies to scheduled rotation flights between the gateway point and Votkinsk often result in "some real messes." He cited instances where there were misunderstandings between the two sides on what types of aircraft the Soviets would need to transport supplies from Moscow to Votkinsk. He said there were also some instances where the Soviets simply refused to allow equipment and supplies to be brought in to the country because procedures were not followed. He said, "You get stuff impounded because the Soviets didn't know it was coming and didn't know what it was when they saw it -- we've got plenty of stuff they've never seen before. Myers and other site commanders said properly preparing documentation for shipments and notifying the Soviets of an impending shipment is almost an artform.

> Providing the needed technical information and documentation (for a shipment) is interesting. It's almost an art unto itself to write documentation to the Soviets because you have to tell them enough to satisfy them. But, if you mention basically anything that's not explained in the document, or make a reference to another document or something else, it just gives them an excuse to demand more pointless detail. Technical and shipping documentation almost has to be tailored to its Soviet audience -- and yet has to be sufficient for Americans to use. (64)

Haver said Votkinsk personnel must carefully prepare themselves and the cargo they are bringing in with them for very detailed customs inspections by Soviet officials.

> Anything going into the Soviet Union from the United States has to go through the Soviet customs inspections. Advising the Soviets, knowing exactly what it (equipment) is, descriptions of that equipment or supplies, having shipping documentation prepared, having all that prepared and delivered to Soviets all in advance for them to review so there are no surprises to them becomes very important and directs the pace of the operation once we begin trying to send the equipment. (42)

Possible technology transfers are also a concern at Votkinsk and are another factor in planning. Haver stated that OSIA officials have instituted special procedures to guard against technology transfers and to stay within export restrictions. Impending shipments are carefully reviewed and this adds to the lead time in the resupply of the site. "Everything that goes in has to be cleared. Obviously, with your basic consumable supplies there is no worry about. But any kind of technical equipment -- anything electronic -- must be checked" (42).

Do INF Logistics Lessons Learned Apply to START?

The Votkinsk Portal Monitoring Facility has been in operation for more than two years now. As stated above, many lessons have been learned in the logistics support of the facility. As the Soviet Union and the United States move closer to signing the START Treaty, the question is: are those lessons learned applicable to START and of use to logisticians planning support of START portal and perimeter monitoring facilities? Although there were come caveats, the consensus among the 18 experts who were asked the question was that they do apply. Englund stated that not only are they applicable, they are probably almost the only ones the U.S. can use in planning logistics support for START portal sites (30).

Myers said that START portal facilities will face many of the same logistical problems as the Votkinsk portal facility, and, therefore, can take some of the approaches used at Votkinsk to solve them.

> Obviously there will be local variations in the problems. There will be local variations in the mission. But I think we'll wind up taking in many of the same general sorts of things. The total amount of hardware is still going to be very large. Structures are going to be generally similar. The number of people will be similar or perhaps larger. We expect to use site operations contractors again, and I think we'll be doing many of the same things that we do in Votkinsk. In

> fact, if you were doing only one START portal site there could be a tremendous resemblance to Votkinsk. (64)

Haver stated that despite the possible technological and engineering differences between INF and START portal monitoring systems and their missions, there will be an ample amount of common experience to share.

> The kinds of problems that we have encountered, the kinds of situations we have encountered, the kinds of planning that we have found we must undergo, I think are characteristic of dealing with the Soviet system anywhere in the Soviet Union. Therefore, absolutely, the lessons we have learned at Votkinsk will be applicable to any site in the Soviet Union to which portal perimeter monitoring is established. (42)

Other officials believe that not only do the lessons learned from Votkinsk apply, but the Votkinsk facility itself is a useful model for planning support of portal perimeter monitoring (PPM) facilities under START.

> I think it can serve as probably a very good model. In fact, the Soviets under START proposed that Votkinsk be used as the portal monitoring facility for START as well as for INF; a concept that the U.S. is opposed to, especially since the Soviets are proposing different facilities than what they monitor under INF for START monitoring. But in terms of the job that has to be done, what we did at Albuquerque and Sandia through the Air Force -- the demonstration model -- plus the way we are actually implementing that model or that equipment, it serves as a good base line. (50)

Ed Herger, the deputy program manager for logistics for the ESD program office that acquired the Votkinsk portal monitoring system, agreed that the lessons learned are applicable. But, he qualified that by saying there will be new logistics planning factors -- namely addressing requirements for supporting multiple locations -- that will add complexity to the logistical system employed. That complexity, however, may have a silver lining, according to Herger.

> In TOSI we had a relatively simple problem of supporting only one site. Although you would gain problems in having more than one site, they could be offset by some economies of scale because you would have a bigger support base. (44)

One Votkinsk site commander said the additional U.S. portal sites that will be activated in the Soviet Union with implementation of the START Treaty will not result in a simple doubling of the workload for logisticians. U.S. Air Force Lieutenant Colonel Mark Dues said that he anticipates that there will be a multiplicative effect that will create the need to revamp the logistical system supporting U.S. arms control sites in the Soviet Union.

> We're not talking about just one portal; we're talking about maybe five portals. And, just from the shear load as well as different requirements from different sites, there's going to be the need for an entirely new expanded infrastructure not just in Washington, not just in Frankfurt, but also in Moscow. We are already talking about a distribution center manned by the U.S. there in Moscow and maybe having a transportation system, which is provided by the Soviets, but which is leased by the U.S., solely dedicated to the supply of the portals. (24)

Kelly agreed that Votkinsk is a useful model for START logistics planning and that its lessons learned do apply to START, but he said its applicability is limited to a certain degree.

> Certainly it is a model of how we have to cooperate on a daily basis with the Soviets.

> Certainly a lot of lessons have been learned since we have been at Votkinsk and had a lot of interaction with the Soviets. We have found certain things don't work very well. We don't want to have those in START. (51)

Kelly stated that the Votkinsk facility is limited as a model because there are logistics requirements unique to supporting a network of portals. He pointed out that it does not answer questions regarding movement of personnel and equipment between sites and between sites and points of entry.

> Are we going to be able to move inspectors between portals, or will an inspector have to come out of the country and then reenter and go to another portal. There're all kinds of questions that need to be asked -- need to be addressed -- before we begin implementing the multiple PPCMS regime in START. (51)

Kelly noted that if and when the START Treaty is implemented, the Votkinsk portal could pose some interesting issues, mainly because the missile assembly plant there produces the SS25. As stated in chapter one, the primary task for U.S. inspectors at Votkinsk is to be able to differentiate between the SS25, which is not a treaty limited item under INF, and the SS20 -- which is -- and verify that the SS20 is no longer being produced. Kelly said that as the START treaty is currently envisioned, the SS25 will become a treaty limited item under START. Therefore, he said, there may be a call for a START portal at Votkinsk. This possibility was also mentioned by Sovich (51;77).

> That raises all sorts of interesting issues of how you have a START inspector and an INF inspector at the same place. Does the guy have two badges, and when he is wearing a blue badge he is an INF inspector, and when he is wearing a gray badge he is a START inspector? It could become interesting because the treaties won't necessarily be the same in the way they treat inspectors and what rights the inspectors have. (51)

Distribution Network Supporting the Votkinsk Facility

The section analyzes the distribution network used to move and store materiel required at the Votkinsk Portal Monitoring Facility. It also traces the flow of that materiel between the United States, Europe and the Soviet Union. A distribution network is made up of facility locations and transportation linkages. Typically, logistics facilities -- the nodes in a distribution network -- include consolidation and distribution centers; warehouses; freight terminals and maintenance centers (7:146). The five modes of transportation -- rail, air, water, motor carrier and pipeline -- are the linkages in a distribution network, providing the means for movement of material between nodes in the network.

The HTSC distribution network for the Votkinsk facility is made up of logistics facilities at Manhattan Beach, CA., Albuquerque, N.M.; Rhein Main Air Base, West Germany; and Votkinsk. As stated in chapter two, the network's transportation linkages are provided by the U.S. Defense Transportation System and the national transportation system of the Soviet Union (47).

Logistics Support Office (LSO). Planning and management control of the VPMF logistics network is exercised by the program's logistics manager who is located at the Logistics Support Office in Manhattan Beach (47:8). The LSO is the office of primary responsibility for the integrated logistics support of the Votkinsk portal facility. It provides management expertise to and coordinates the activities of the logistics facilities in the network. Activities performed by the Logistics Support Office include defining supply support plans and requirements for the VPMF; property, material and inventory control; repair management; oversight and guidance of procurement activities in the United States, Europe and the Soviet Union; and the provision of expertise to logistics facilities in the network in the packaging, handling, storage and transportation of equipment, supplies and other material, including hazardous material (47:8-11).

Albuquerque Engineering Liaison Office (ELO). The other HTSC logistics facility in the continental United States is the Engineering Liaison Office in Albuquerque. Although primarily involved in software maintenance support and liaison with the monitoring system developer (Sandia National Labs), the office also serves as a consolidation warehouse for shipments of material from CONUS vendors (28;39).. HTSC personnel there procure and receive material from vendors, and then arrange for the packaging and shipment of the items to Rhein Main Air Base, West Germany.

Most of the shipments from Albuquerque are with the Defense Transportation System. Gloe stated that personnel there use the Traffic Management Office at Kirtland AFB in Albuquerque to clear shipments into the system (39). Gloe also said that the Albuquerque office occasionally uses U.S. Express Mail to move small packages requiring next day service to the Frankfurt area.

The office also coordinates depot repairs with the HTSC FOE. The Albuquerque office keeps a database of the U.S. vendors who supplied the prime mission and support equipment used in Votkinsk. That database includes warranties. If an item requires depot level repair, the Albuquerque office finds the original vendor, checks for a warranty and determines whether or not the vendor has a repair facility in Europe or an operating agreement with a European company for repair of the equipment. If there is no repair capability in Europe, then the item is returned to Albuquerque through the Defense Transportation System or U.S. Express Mail (39).

HTSC used the Albuquerque site as the focal point for the packaging, documentation, and deployment of the prime mission and support equipment, spares and supplies during installation of the Votkinsk facility. That activity lasted from July 1988 to Spring of 1990. According to Embree, physical distribution activities at Albuquerque have since been scaled back now that the system has been deployed. The logistics strategy for the VPMF is to limit as much as possible the procurement of material in the United States and instead purchase only in Europe, reducing lead times and transportation costs (47:28;28).

Field Office Europe (FOE). The second facility in the network is the HTSC FOE located at Rhein Main. It serves as the primary consolidation warehouse. It receives shipments from the United States and from commercial vendors and military supply sources in Europe, and then consolidates them for movement on MAC aircraft to Moscow. The facility packages, prepares required shipping documents to meet MAC and Soviet requirements, and coordinates with OSIA officials and the MAC aerial port at Rhein Main on the movement of site personnel and material between Rhein Main and the Soviet Union (28;47:9,11-12). It also acts as a depot in managing repair and replacement actions. As a depot, it accomplishes the following actions if required: 1) purchase replacement parts if the are not economically feasible to repair; 2) return parts to vendors for repair; or 3) exchange parts with vendors. Other functions include the local procurement of food and other commestibles for the resupply of the site, and the support of inspectors rotating in and out of the Soviet Union (47:12).

VPMF Warehouse. The final facility in the network is the Votkinsk warehouse, which, in effect, is the retail outlet in the network for the servicing of customers. It receives shipments; provides storage and movement of inventory items; makes issues to authorized personnel; initiates replenishment actions based on stock reorder levels and customer orders; and receives, packages and ships retrograde cargo from the site (47:9,11).

Transportation Terminals. In addition to the logistics facilities managed by HTSC, there are several transport terminals which are part of the overall logistics network. Surface and air freight terminals serving as transfer points are Kirtland AFB, NM.; Cannon AFB, NM., Tinker AFB, OK.; Rhein-Main Air Base, West Germany; Sheremetyevo-2 International Airport near Moscow, USSR; and Izhevsk Airport, Izhevsk, USSR, which is about 50 kilometers from the Votkinsk Site.

Inventory/Material Flow Pattern. The flow of equipment and material through the VPMF distribution network is similar to the flow of an "Echelon System" described by Bowersox (10:54). Products flow from vendors in the United States and Europe (origins) to the logistics facilities at Albuquerque and Rhein Main, which act as consolidation warehouses. The facilities consolidate the small vendor shipments into larger outbound shipments ultimately destined for Votkinsk. In the case of the HTSC FOE, it consolidates shipments from the Albuquerque ELO with shipments from European vendors. Then the large shipment is airlifted from Rhein Main to the VPMF, where it is received and broken down at the retail warehouse. Items (to include food) are then either delivered to the customer, or stored in the warehouse or food storage areas for rapid delivery upon receipt of customer orders.

Stateside, shipments arrive at the Albuquerque ELO by motor carrier on a commercial bill of lading. After the shipments are received and inspected, they are usually entered into the Defense Transportation System. From there, the shipments move either by MAC SAAMs direct to Rhein Main, or are taken to the MAC terminal at Tinker AFB, OK., by government-contracted air carrier or by motor carrier on a government bill of lading (GBL). Shipments then leave Tinker on regularly scheduled MAC channel missions to Rhein Main.

When the shipments arrive at Rhein Main, the HTSC FOE there is notified by the 435th Aerial Port Squadron through the OSIA FOE. A majority of the time, the shipments are physically held at an aerial port warehouse because of limited warehouse space at the HTSC FOE.

The HTSC FOE takes the CONUS-originating shipments and consolidates them with European-originating shipments. The consolidated shipments are then reentered into the DTS and normally carried to Moscow aboard a recurring MAC Special Assignment Airlift Mission (SAAM). It departs Rhein Main for Moscow every three weeks. Its primary purpose is to carry U.S. personnel serving at the Votkinsk INF Site.

Moscow serves as the Point of Entry/Exit (POE) into the USSR. At Moscow, cargo and passengers are usually customs inspected by Soviet personnel and then loaded aboard an

Aeroflot aircraft for the flight to Izhevsk. From Izhevsk, passengers and cargo are taken by motor transport to the U.S. portal facility. The vehicles are provided by the Votkinsk Industrial Organization, which is part of the Ministry of Defense Industries.

The bulk of cargo flowing from Rhein Main to the Soviet Union is food. As stated earlier in this chapter, the OSIA resorted to food shipments from Rhein Main after attempts to buy adequate stocks of food from the Soviet economy failed. Most of the food is purchased from the Rhein Main commissary, while the remainder of it is purchased from German food vendors (28). Typically, food orders are containerized a day or two before the SAAM mission departs Rhein Main. Perishables are containerized the night before the mission. Scheduled departures are every third Tuesday at about 0600 hours Central European Time. Embry reports that the food usually arrives at the site no later than 2200 hours local time in Votkinsk, which is two hours ahead of Rhein Main.

Transportation Approaches. There are two approaches in the transportation of equipment and supplies from Rhein Main to Votkinsk. The first and primary approach is the use of the tri-weekly personnel rotation flights mentioned above to Moscow with onward movement to Izhevsk on Soviet passenger aircraft, usually the TU 154; and the second is the use of the rotation flights and the onward movement from Moscow on Soviet all-cargo aircraft (47:53-55). The second approach is referred to as "cargo dedicated flights" by OSIA and HTSC officials. Up until the middle of 1990, such flights were to be used as a last resort with an "overall goal . . . to virtually eliminate" them and rely on handcarrying resupply items to Votkinsk (31:3).

The first approach basically calls for equipment and supplies to be carried as excess passenger baggage. The excess baggage is referred to as "handcarried items," and, in addition to normal passenger luggage, includes water; fresh, frozen, semi and nonperishable food (containerized in picnic coolers); and high-priority items needed at the site. Handcarried items do not require the special cargo shipping documentation or the advance notice to the Soviets required under the Memorandum of Agreement (MOA) between the two sides relating to the INF Treaty. But, if any item is part of the monitoring system at Votkinsk, it is subject to special inspection and documentation requirements outlined in other sections of the MOA (31:1). OSIA guidance is that as a general rule there should be no more than about 450 cubic feet and/or 10,000 pounds of handcarried items on each rotation flight, and each item should be small enough to fit through the passenger doors of Soviet aircraft (31:2; 42). According to Embree, the total weight of these types of shipments have averaged about 6000 to 7000 pounds.

Limiting the volume and weight of these types of shipments was of special concern to OSIA officials because of the workload on U.S. inspectors and their Soviet escorts in moving it. The following was a written reminder about planning for these types of shipments:

> When planning what should be included on the C-141 as baggage, remember that the inspectors will have to carry it five or six times on and off busses and airplanes. Food items will normally be transferred directly from the C-141 to the Soviet aircraft upon arrival in Moscow, but all other items will have to be carried up and down three flights of stairs at Moscow's Sheremetyevo Airport so the Soviets can inspect it. (31:2)

The second transportation approach calls for equipment and supplies to be moved strictly as cargo. This requires that special shipping documentation be prepared to meet provisions in the MOA. This type of shipment is also usually moved on the tri-weekly rotation flights into Moscow with the inspectors, with as many as seven pallets of cargo being moved. From Moscow, however, the pallets are transported on Soviet cargo aircraft, usually the Il-76, and are not accompanied by U.S. inspectors. OSIA officials define items that qualify as cargo as follows:

> These items include any oversized or heavy objects which one inspector could not comfortably carry or which are crated together with other supplies and equipment. Those supplies and equipment stored at Rhein-Main AB considered too large to be comfortably handcarried or which have not been included as baggage on previous flights because of a lower priority assigned it by the Votkinsk site commander with the assistance of HTSC, could be included in a cargo shipment. Food, if properly packed, palletized, and documented, can also be included in a cargo shipment (bearing in mind that the cargo could sit in Moscow for several days). (31:2)

This type of cargo shipment requires more lead time. As stated earlier, special shipping documentation has to be prepared in accordance with the MOA, and it has to be delivered to the Soviet government in Moscow ten days before the shipment arrives in Moscow. This is to allow the Soviets time to plan and schedule materials handling equipment at all transshipment points within the Soviet Union and to schedule the required aircraft. The OSIA requires that HTSC logisticians begin coordination of such shipments two months in advance of the actual movement (31:2).

Distribution Issues. There are two issues regarding shipments of equipment and supplies between Votkinsk and Rhein Main. The first is the movement of shipments as "handcarried baggage." The second issue is the movement of retrograde cargo from the Soviet Union to Rhein-Main Air Base.

Shipping cargo as handcarried baggage is very labor intensive, and it surfaced as a point of contention between the two nations on several occasions. It has also caused a backlog of cargo to build up and exceed the capacity of the HTSC logistics facility at Rhein Main.

The U.S. agreed to a Soviet request to limit requests to the Soviet government for all-cargo aircraft to transport equipment and supplies between Moscow and Votkinsk. This was in return for U.S. inspectors being allowed to carry as much as 10,000 pounds of baggage with them on passenger flights between Moscow and Votkinsk (42:28). The U.S. agreed to the arrangement in return for the Soviets providing baggage handlers at Moscow, Izhevsk and Votkinsk to handle the increased baggage on the rotation flights (25:3-4). For nearly 21 months there was a probler with the Soviets providing enough baggage handlers, according to Haver. Often, Americans would have to handle the baggage themselves or help the one or two Soviet baggage handlers provided. On several occasions, U.S. inspectors had to carry part of a baggage shipment up three flights of stairs at Sheremeteyvo Airport for a customs inspection and then bring it back down to the aircraft. The problem appears to have ended, for now. Haver said, "Baggage handling has been standardized and they (the Soviets) are providing the bodies now." One problem that still remains is damage to items in the baggage from repeated handling and exposure to the weather once its offloaded from aircraft at Izhevsk, according to Haver (42).

The agreement to limit the amount of cargo on the rotation flights has led to another problem, according to Embree. It has created a transportation bottleneck between Moscow and Votkinsk, resulting in a backlog of equipment and supplies waiting to be shipped from the FOE warehouse at Rhein Main. The warehouse was designed to be a consolidation warehouse with room for only short term storage of equipment and material (28). According to Embree, the amount of material and equipment that was being ordered by the Votkinsk facility was at a rate that exceeded the artificially determined level of transport capacity.

Most of that capacity was being taken up orders of perishable foods. As a result, queues of material and equipment built up, exceeding the capacity of the warehouse. Excess items had to be stored at aerial port warehouses at Rhein Main Air Base (28). Another result of the shortfall in transport capacity was that the stocks of dry goods and other commestibles brought in during the initial deployment to the site were being depleted (28). On 29 May 1990, a dedicated cargo flight from Rhein Main carried much of the backlog at the FOE along with a shipment of commestibles to replenish stocks at Votkinsk. The cargo was transhipped from Moscow aboard a Soviet Il-76 aircraft the Izhevsk Airport near Votkinsk. According to Haver, the OSIA has decided to schedule dedicated cargo flights every six months to move non-perishable supplies to stock the site and help diminish the backlogs of cargo in warehouses at Rhein-Main Air Base (42).

There has not been much flow of retrograde cargo. But, Embree and Myers expect this to change. According to Embree, not much was anticipated until a railcar x-ray detection system called CargoScan was operational. That system was activated on 21 March 1990. While the CargoScan is now on line, there apparently are no set procedures to ship retrograde cargo out of the Soviet Union. Myers stated that this still has to be worked out with the Soviets (64).

> We've have this fairly good system of getting stuff into Votkinsk, but one thing we haven't gotten all that good at is getting stuff back out

> of Votkinsk . . . We haven't made many attempts to put stuff on Soviet aircraft back to Moscow. I know of one attempt that was made, and it didn't work simply because the Soviets had not scheduled the aircraft back to Moscow. (64)

Myers said that usually retrograde cargo is carried out by inspectors rotating back to West Germany. Individual pieces of cargo have been small enough to be handcarried. However, empty aircraft pallets and other equipment too large to be handled manually were shipped out on MAC C-141 aircraft that were allowed to fly into Izhevsk during the later stages of the deployment of the monitoring system and support equipment in late 1988 and early 1989 (64).

Logistical Network Supporting START Portal/Perimeter Sites

Can the distribution system used to support the Votkinsk portal facility be used to support similar facilities under START or will a new system be required? This section presents expert opinion regarding this question.

Most of the experts interviewed stated that there is a strong possibility that changes will have to be made to the existing logistical system that supports the Votkinsk portal, but the degree of those changes depends on the number of START portal facilities that will be allowed on the sovereign territory of each inspected party. However, at least one expert pointed out that there is a slight possibility that the existing logistics system can be used for START. Haver said that if the Votkinsk portal facility also becomes a portal facility under the START Treaty and is the only U.S. portal facility allowed under START, he sees little need for restructuring the existing logistical network (42).

Myers stated that the current logistical network evolved because the Votkinsk portal facility, with its mission and required monitoring equipment, is a "single and unique site." He said the treaty allowed a "very large" warehouse to be built at the Votkinsk site even though the United States could have established it anywhere else. However, "because so much of the system is unique, because we're not doing this somewhere else, basically the most logical place for us to store things is in Votkinsk," Myers said (64).

Logistics Facilities. But this situation will apparently change under START. Haver and Myers believe that the existing logistical system will have to be modified, even with the addition of only one or two START sites. They said the additional facilities would create the need to centralize stock away from the sites and reduce the number of line items stocked at each site. Myers stated that despite the fact that monitoring systems employed at each site may vary to some degree, there should still be a common spares inventory and common requirements for such commestibles as food, administrative supplies, housekeeping supplies, and clothing. He said, for instance, that the sites will consume "reams and reams of paper" and other material such as copying machine toner that are difficult if not impossible to procure in the Soviet Union. He said this material may seem trivial compared to other items such as spare parts for prime mission equipment, but he countered that documentation is an integral part of monitoring treaty compliance. As a result, safety stocks of these items will probably have to be kept inside the Soviet Union to guard against disruptions in supply or variations in demand. He also pointed to other more expensive items that will be common to each site and will require that safety stocks be kept.

> Right now we maintain some number of spare video cameras at Votkinsk. We keep them all at Votkinsk because, well, why not? That's where the requirement is, that's where the warehouse is. We may in START have a requirement for substantially more video cameras per site, so we'll have probably more spares on site; however, it's probably going to be the same camera on every camera tower at every site so that if we try to build an inventory to cover, say, some calamitous event -- a lightning storm wipes out a whole bunch of cameras at a site or something -- we don't have to do that at a site. We have some at every site, we could have a backup supply somewhere else, and if something really bad went wrong at one site you could bring in the one reserve supply, maybe take a few from the other sites, and deal with something like that. You'd keep enough at each site for the normally expected failures. (64)

Haver, Myers, Dues and Englund all said that there may be a need for a logistics facility in Moscow. According to Haver, the threshold for establishing such a facility would be the number of portal-perimeter monitoring facilities agreed to under the START Treaty. He said the OSIA would have to give some "serious consideration" to establishing a logistics facility in Moscow if there were five or more U.S. inspection facilities established under both treaties.

There were several scenarios proposed for a logistics facility in Moscow. According to Myers, under one scenario a distribution center would be established in Moscow and would handle shipments from a central warehouse in the Frankfurt area or some other location in Western Europe. In addition, it would consolidate retrograde shipments of cargo from treaty monitoring sites for onward shipment out of the Soviet Union and back to Western Europe. He said that relatively high-cost items with low rates of demand could be centrally stocked in Western Europe. Other less expensive items with stronger demand could be warehoused in the Soviet Union, either at the distribution center in Moscow or at one site and moved to other sites as required. Dues makes an even stronger point for establishing a Moscow logistics facility.

> With the number of sites that we could have, we are probably going to have to have a logistics facility right there in Moscow. Not only for supplies, but also, for example, maintenance people. Maybe to travel around from site to site to take care of equipment. Just for economy of scale, making sure that you don't necessarily have maintenance people stationed at each site sitting around twiddling their thumbs waiting for a little widget to go haywire when they could be travelling around to other sites where the widgets have gone haywire and taking care of those things and making them more efficient. That's the maintenance aspect of it. As far as supply, we have to look at having a warehouse distribution center right in Moscow. And order things from Moscow and have them transported. (24)

Haver proposed that the Moscow logistics facility would be a central warehouse while the present logistics facility at Rhein Main would have to be expanded and would be the primary purchase and requisition office.

> The reason for doing that is that, with that kind of volume we are dealing we want to be able to bring things in and store them, get them inspected in Moscow, get them stored for distribution to whatever site needs it, and we would expect to be able to use whatever aircraft happen to be coming in. Right now we are using essentially a couple of planned cargo flights a year plus our Votkinsk portal rotations. We are not taking advantage of the supply capabilities of other INF flights that go into Moscow. And depending upon the number of sites that are established under START, I think we need to be able to take advantage of those other kinds of flights. (42)

Dues sees other requirements for a Moscow logistics facility. He stated that under the INF Treaty, the OSIA and its contractor have no capability in Moscow to handle deliveries by food or product wholesalers/retailers based in Helsinki, Finland, which is only 500 miles from Moscow. Those firms supply many western diplomatic missions and business firms based in Moscow. He believes the OSIA must investigate alternative sources of food for its treaty monitoring facilities in the Soviet Union. But, without a facility in Moscow to handle food shipments from vendors, it would not be feasible to use those alternative sources, he said.

> One of the things that we had to make clear to the contractor is that it might be easy to order, say, from Stockman's (Helsinki, Finland) and get it to Moscow because that is being done time and time again with the embassy. But something that the contractor couldn't understand was getting it from one airport in Moscow to another airport and getting them out to Votkinsk. It could be a logistical nightmare primarily because the infrastructure at this time is just not in place

> to move supplies from one area to another. And the Soviets aren't crazy about doing something like that either. And it's probably going to have to be done later on by a U.S. team that's permanently based in Moscow. (24)

In Moscow, the ACIU provides a limited logistics support function for the Votkinsk portal facility. To adequately support a combination of the Votkinsk facility and START portal perimeter facilities, Dues believes that the ACIU's logistics responsibilities will have to be expanded.

> It is a facilitator. But you have to understand that its original intent and therefore the resources given to it were to facilitate bringing teams in and out of the country and passing information. They were not manned and they were not given the equipment in order to be a large logistics endeavor. And if anybody wants to do that immediately, we don't have the resources right now to do that. But as I was saying, under a START regime, if you call it an ACIU -- Arms Control Implementation Unit -- fine. But, you've got to say 'What is it for?' Is it to continue doing, on a larger basis, what it's been doing. Or is there going to be a logistics function attached to it as well. You've got to ask and answer those questions. (24)

Myers saw another scenario where the United States would need to further expand its network of logistics facilities under START. He said that if portal monitoring facilities were established outside missile assembly or rocket motor plants in the eastern Soviet Union, the U.S. would probably need a distribution center in Japan. He said it would have about the same function as the current logistics facility at Rhein Main under the INF Treaty.

Eimer thought a logistics facility in Moscow was a good idea and one that should be pursued by the U.S. in talks with the Soviets. But, he had doubts about the Soviets' reaction to such a U.S. proposal.

> I just wonder if you would ever be able to do it with the Soviet Union, simply because you have to get permission for everything you move into the airport. I don't know if they would ever say you could bring in lots of spare parts. And, after that, the Soviets could no longer control it. The way the Soviets operate, they would not do that. The thing I could visualize, remotely, is that they would permit a warehouse which they control. We might bring things into the airport to store, but they would still be in control in terms of what goes out. I can not imagine they would let it move out freely. (26)

Johnston stated that the United States should avoid the storage of material at a central warehouse location inside the Soviet Union. He said each portal perimeter monitoring facility should have a warehouse similar to the one presently used at the Votkinsk portal facility.

> There are a lot of drawbacks to keeping things there [in Moscow]. Things could get stolen, damaged, or pilfered. In START, I think they're looking at about six different locations, So, once it got there, then it would be the Soviets' responsibility to disperse it to the different locations. So you put the onus on them. You'd have to have storage facilities, and we've got that in the INF Treaty. I think we would rely on storage at the location itself. (50)

Johnston argued that the U.S. could use this type of network without higher logistics costs such as those for inventory investment and storage associated with the additional safety stock that would be required. He said that the U.S. should instead rely on premium transportation. He also doubted that it would be easy to procure a facility in Moscow.

> I can't imagine them building another building. It's sure rough to do that, though. The simplest thing, I think, would be to rotate more airplanes through. If you're going to have to carry that bulk of material in there, you're going to have to use the same amount of airplanes anyway. You might as well just structure the flight schedule to permit that to happen. (50)

While there may be some merit in Johnston's argument about the Soviets not being receptive to building a warehouse facility in Moscow, his position on inventory costs is open to debate. Usually, there are higher inventory carrying costs and investment required with holding inventory at multiple locations as he recommended. This could result in an increase in the total logistics cost in supporting a network of START and INF facilities once the START treaty is implemented. Usually when premium transportation such as airlift is used in the way that Johnston suggests, there are more opportunities to centralize inventory items. Often, the result is lower total logistics costs while roughly maintaining the same level of customer service.

Transportation Links. It appears the OSIA will continue to rely on aircraft for movement of U.S. inspectors, supplies and equipment between Moscow and portal monitoring sites after the START Treaty is implemented. Considering the many problems with the rail system in the Soviet Union and the relative roadlessness of the nation as outlined in Chapter Three, the OSIA or their Soviet hosts may not have any choice but to move equipment and supplies on aircraft.

Based on the extensive number of airports served by Aeroflot -- more than 3500 -- there should be an airport fairly close to any location chosen to base U.S. START facilities.

Even if there were one or two facilities that could be supplied by motor carrier, Myers doubts that common carriers in the Soviet national transportation system can provide the same level of safe, dependable service provided by common carriers in the United States. His perception is based on the attitudes of Soviet officials within the Ministry of Defense Industries and the Soviet counterpart to the OSIA. Myers also stated that the ministry "has shown a strong preference" for using aircraft rather than trains to transport OSIA personnel and cargo.

> They are reluctant to trust the common carrier networks, a personal opinion of mine, with the stuff they're consigning which has a hard currency value. I mean if the stuff could be stolen enroute, it would be. The common carrier system is subject to long delays. Even if stuff gets to its destination consistently, they just flat don't know when it will. So that has held down what would otherwise be a much larger attempt on our part to buy things from the foreign currency trade organizations in Moscow. (64)

Myers said that the INF treaty has given OSIA some advantages in distributing its materiel. He said the passenger and cargo flights on Aeroflot aircraft used by the OSIA between Moscow and Votkinsk are "laid on" by the Ministry of Defense Industry, which also has the responsibility of escorting U.S. inspectors and supplying the Votkinsk site in accordance with the INF treaty. Myers said the OSIA generally gets the support flights any time they want them. Private motor carrier transport is provided by the same ministry.

Haver stated that currently there is no set schedule with the Soviet government for the movement of supplies and spare parts from the point of entry at Moscow to the site, although there is one for passenger movement. He said that there is a procedure for scheduling the airlift of cargo.

> We inform the Soviets at least 10 days in advance that we will require shipment of cargo. We provide them with a list of the equipment, the size and weight of the individual pallets of equipment and supplies. So actually, our requirements from the Soviets are relatively simple. It becomes their responsibility to schedule the aircraft for which we pay. There is no regularly scheduled cargo flights to the locations. On the other hand, the Soviets have been very responsive giving us cargo flights when we have requested them. Generally we have tried to maximize our rotation aircraft - that is when we have a cargo pallets to bring in, we bring them in with - on the same flight as the rotation and the Soviets have turned around and sent them within a few hours to Votkinsk. (42)

Under the START Treaty, Myers and other site commanders envision a marked increase in the use of Aeroflot aircraft for logistics support of treaty monitoring sites. Conceivably, inspectors and supplies could be moved directly from one site to another, according to Myers. Rather than using an Aeroflot aircraft once every three weeks as is done now to rotate inspectors and move supplies for Votkinsk, Myers said rotation and support flights may be required every week.

> We could expect to basically combine some rotations; run a flight once a week carrying passengers and cargo from more than one portal at

> a time. So, we'd have Aeroflot passenger and, occasionally, cargo flights splitting off into more than one location. We may have passengers with an awful lot of excess baggage conceivably moving from one place to another on scheduled flights. Excess baggage on Aeroflot is bad news but they'll carry it for a price of course. Very often you wind up carrying your baggage on and off the aircraft. Even the checked baggage, in a lot of cases, you're the person transporting it. (64)

Dues said that the U.S. may need to enter into some sort of service relationship with Aeroflot to provide a relatively dependable and consistent transportation link between a distribution center in Moscow and START portals. "I think that's doable," he said.

Communication Links. Under the START Treaty, with the possibility of the U.S. establishing multiple portal perimeter monitoring sites and logistics facilities in Moscow and Western Europe, communication problems could hinder the efficient and effective movement and storage of spare parts and supplies. As stated earlier in this chapter, the existing communication network used to support Votkinsk is plagued by a low-quality, unreliable telephone system that among other things cannot support computer networks. Also, with the multiple sites and logistics facilities, there is the question as to how much communication the Soviets will allow between the sites and between the sites and the central warehouse and/or distribution centers supporting them. This becomes important as far as collateral support where, for example, one site could quickly send a needed spare part to another site rather than wait for the requisition to be filled through normal supply channels.

> Communications have worked as well as can be expected [at Votkinsk]. The telephone quality is not sufficient between Moscow and the site. Going into Moscow [from Europe and the United States] seems to be OK. But, telephone communication is a problem. A satellite link obviously would help the situation [under START and INF], but that's something that has to be negotiated. (77)

Once the START Treaty is implemented, Myers said that the OSIA hopes to have pretty easy communication between the sites, and the right to exchange people and supplies among them to hold down the total number of spares and maintenance specialists needed to support the network of sites. Myers said that the right for START sites to communicate with each other will have to be negotiated. He said that he did not know what the exact outcome will be, but he said the U.S. will have "some such right" to do so. "I don't know the details but I believe that we will be able to have some interchange of people and supplies among the sites," Myers said.

<u>Negotiations to Determine Network Structure</u>. Most experts interviewed made it clear that the United States cannot unilaterally determine the structure of the logistical network supporting treaty monitoring sites based solely on integrated logistics management concepts. Political and diplomatic considerations will also be factors affecting decisions about the structure of the network. Also, whatever the final network structure is, the experts

stated that it will be determined during diplomatic negotiations related to the treaty and formalized in agreements such as memorandums of agreement or understanding.

Perhaps at the core of these talks will be the concept of reciprosity. Any proposal for logistics support put on the table by either the U.S. or the Soviet Union must be reciprocal in nature. If the United States does push for a warehouse in Moscow at Sheremetyevo Airport, it must also be prepared, for example, to allow a Soviet warehouse at Dulles International Airport near Washington, or perhaps at San Francisco International Airport or at Travis AFB near San Francisco.

Another reciprical consideration is transportation support. It would be much cheaper and convenient for each side to fly its inspectors, supplies and equipment directly to the nearest airport to each treaty monitoring site instead of to points of entry in each nation where cargo and passengers would have to be transloaded, creating more work and expenses and increasing the chance that cargo will be damaged or mishandled. During deployment of furnishings and other support equipment to Votkinsk in December 1988 and the first two months of 1989, MAC C-141B aircraft flew the cargo to Izhevsk Airport, the nearest airport to Votkinsk. This was done instead of flying the cargo to the Moscow point of entry for transhipment after the Soviet government requested the U.S. to do so (43:1-3; 73:1-2). During this time, most

Aeroflot aircraft were commited to relief efforts of Armenian earthquake victims. U.S. officials carefully made it very clear to the Soviet government that this was not a reciprocal arrangement, ruling out the possibility that Aeroflot aircraft could carry payloads into Salt Lake City, the location of the nearest airport to the Soviet INF Treaty monitoring facility at Magna (36).

While all experts agree that both sides will have to agree on procedures for the movement and storage of material for treaty monitoring facilities, the question remains about when in the negotiation process do the parties involved hammer out the agreements. Myers, Higgins, Eimer and others believe that most agreements about logistics support procedures and facilities should not be in the START Treaty itself.

> We will certainly have what you might consider our own distribution system in the Soviet Union . . . And, you could say that negotiations will be necessary. Certainly a tremendous amount of talking and writing in some form will be necessary to work out the details of how the Soviets will move our people around, move our cargo around, and hopefully sell us a lot of what we need if they can manage to do that. But in the sense of putting it into the treaty, again that would be a bad move because one, it's hard even for us to anticipate what will need to be done except by working it out as the occasion comes and two, it could clog up the treaty with too much stuff that doesn't need to be in the treaty. (64)

Eimer had similar concerns about the appropriateness of including specific language about logistics in the START Treaty. He said that agreements on logistics support should be "negotiated very late in the process."

> Part of the reason is this is not the kind of issue that the Party Secretary and the President, and those kind of people, worry about. They will be involved in the negotiation as to how many sites and where they are. I'm just guessing that logistic details won't be negotiated until we decide how many sites there will be and where they are. And my guess is that will be very late in the negotiating process. (26)

While most experts stated that logistics agreements should be reached late in the negotiating process, one expert cautioned that some logistical issues may have to be negotiated early on. Johnston stated that if the U.S. decided that it would require some sort of logistics facility in Moscow, it should be negotiated as far up in the negotiation process as possible. This is mainly because it involves a decision on whether a facility will have to be constructed or an existing one provided by the Soviets. Johnston said this would take cooperation by both sides and it would probably have to be included in the treaty itself (50).

Still, most experts interviewed were against including too many specifics about logistics in the treaty. U.S. Navy Commander Edward Higgins of the OSIA's Negotiations Plans Office cautioned that including too much logistical details in the treaty could hinder OSIA officials in effectively implementing the treaty provisions.

> What you don't want to do is have your logistics in a treaty text proper because then it's law. It supercedes any law in the United States. So that's the way you have to do it. And then if you want to modify your procedures -- if it's in the text of the treaty -- you have to go back to

> Congress and have them reratify those portions you want to change. And you don't want to do that. (46)

It is apparent that language in the START Treaty concerning logistics support will be "barebones," with general references to what each party will provide and how it will provide it. It will be the responsibility of those agencies implementing the treaty to negotiate the specifics in an executive agreement, which can be changed (46).

> If you want a different kind of airplane, that's fine. But what you don't want to do is specify "these are the only kind of airplanes you can use" in the treaty itself, because then you are locked in. (46)

V. Conclusions

This chapter presents conclusions about the four investigative questions posed in Chapter One concerning logistics support of U.S. on-site inspection facilities in the Soviet Union under the INF and START arms control treaties. The questions were asked to better understand the factors involved in providing logistics support for these treaty monitoring facilities. Answers to these questions should provide another source of information for U.S. officials in negotiating agreements with the Soviets under the START Treaty for support of U.S. portal perimeter monitoring facilities in the Soviet Union. The conclusions reached in this thesis, along with recommendations for future research, which will also be presented in this chapter, were based on the literature review presented in Chapter Three and interviews with experts which were analyzed in Chapter Four.

Research Conclusions

This section discusses conclusions regarding the analysis of information gathered in answering the four investigative questions.

Investigative Question Number One. What are the logistics lessons learned from the deployment and operation of the U.S. portal monitoring facility at Votkinsk, U.S.S.R., under the INF Treaty?

A framework was required for answering this question, so the ten basic elements of integrated logistics support were used to present the lessons learned from the Votkinsk portal facility. Officials associated with the Votkinsk facility gave lessons learned which were categorized under seven of the ten ILS elements. They were as follows: 1) Maintenance Planning, 2) Manpower and Personnel, 3) Supply Support, 4) Technical Data, 5) Facilities, 6) Packaging, Handling, Storage and Transportation, and 7) Design Interface. Additionally, there was one other lesson learned -- "planning" -- which did not necessarily fall under any one ILS category. However, "planning," which is at the core of the ILS concept, was a common thread that ran through most of the categories of lessons learned.

The most significant lesson learned was in the area of supply support. The conclusion regarding this lesson is that OSIA officials made an incorrect assumption about the quality of Soviet goods and services that would be reliably and timely provided to the Votkinsk facility. When the facility was first activated, OSIA officials had a policy to buy as much as possible from the Soviet economy in order to save time and money in the resupply of the Votkinsk facility. However, within a few months it became apparent to OSIA officials that the third-world economy of the Soviet Union could not provide even the most basic consumer items in a dependable fashion at levels of quality that are taken almost for granted in the West. This is not to say that the facility could not operate effectively in the short run on only Soviet-provided goods and services. Nearly every site commander or deputy site commander interviewed stated that the Soviets have been able to provide logistics support such as food, building material, and electrical supplies, and that U.S. personnel could operate the site in the short run utilizing these goods. But, the fact remained that many items were of low quality and not provided in a dependable fashion. Therefore, in the long run to ensure better working conditions for personnel and a more reliable logistics support system, the OSIA modified its supply policy. It was recognized that almost every good and service consumed at the site would have to be imported from the West. This included common items ranging from food and toilet paper to light bulbs, electrical wiring, conduit and other common comestibles.

The end result of all of this is that OSIA leaders must carefully plan and manage the movement and storage of consumables and reparables for the effective functioning of the site. It must be assumed that very little can be purchased locally and that lead times for goods not available on site will be relatively long, even despite the fact that airlift is the primary transportation link in the distribution network supporting the site.

Investigative Question Number Two. Are Votkinsk logistics lessons learned applicable in planning logistics support for the deployment and operation of U.S. Portal

Perimeter Continuous Monitoring Facilities in the Soviet Union under the START Treaty?

Clearly, the lessons learned from Votkinsk are applicable in logistics planning for START facilities. The Votkinsk portal represents the first instance in history where the two nations have agreed to have a continuous on-site inspection presence within each other's territorial boundaries. This activity represents the second largest official U.S. presence in the Soviet Union behind the U.S. Embassy in Moscow. The OSIA has learned to operate and support a facility in a remote area of the Soviet Union in implementing the provisions of the INF Treaty. It has done so within political, economic and cultural constraints, and has learned some lessons along the way. While START portal perimeter monitoring systems may differ in some respects from the system employed at Votkinsk, both must still operate in the same environment. Therefore, many logistics lessons will apply.

From a macro level, START and INF portals will have much in common. There will be similar numbers of personnel at each type of facility. These personnel will have nearly identical requirements relating to messing, medical care and morale, recreation and welfare. Both types of facilities will employ fairly sophisticated systems which will have to be maintained. The different facilities will also probably be located in relatively isolated areas of the Soviet Union. Another commonality is each will depend on long lines of communication stretching perhaps all the way back to the United States, with few opportunities for local purchase of supplies and services because of the backwardness of the Soviet economy. Finally, both types of facilities will have to function effectively under unique operating conditions. Site commanders and their personnel will deal everyday under the heavy hand of Soviet bureaucracy and sometimes cumbersome treaty provisions. Planning and careful coordination will have to be done for even the most minor logistics activities.

Investigative Question Number Three. What is the distribution system that supports the Votkinsk Portal Monitoring Facility and how does it operate?

The distribution system stretches more than 8000 miles from Votkinsk to Manhattan Beach, CA. It is managed by the Hughes Technical Services Company with oversight by the On-Site Inspection Agency. The flow of material through the system is characteristic of "echelon systems" described by Bowersox. Requisition orders made by authorized personnel at Votkinsk (customers) are filled by vendors in the United States and western Europe. Vendor shipments are usually received at logistics facilities -- nodes in the system -- located at Albuquerque, NM., and Rhein-Main AB, West Germany. The facilities, among other mission responsibilities, serve as consolidation warehouses. Small vendor shipments are often combined at these facilities into larger shipments for onward transport. Shipments from

Albuquerque are sent to Rhein-Main where they are combined with shipments from European vendors before transport to the Soviet Union.

Transportation linkages are primarily provided by the Defense Transportation System of the United States and the Soviet National Transportation System. Within each system, the mode most often used is air transport, a premium transportation mode in terms of cost and service.

The DTS has proved to be very effective in the movement of OSIA cargo between logistics facilities in the West and the point of entry at Moscow. In the United States, cargo is moved in some cases by motor freight carriers between the HTSC Albuquerque logistics facility and military air terminals at Cannon AFB, NM., or Tinker AFB, OK. Between these two air terminals, the air terminal at Rhein-Main and Moscow's Sheremetyevo Airport, Military Airlift Command and MAC-contracted commercial air carrier aircraft are used.

The Soviet National Transportation System has been able to dependably support the U.S. facility at Votkinsk, despite the many problems it has in supporting the Soviet economy. The reason the system has worked well in support of U.S. arms control activities within the country is the high priority the Soviet government has given towards the movement of U.S. personnel and cargo. The support has worked primarily because air transportation has been used exclusively. As far as cargo, air transport limits the amount of time the U.S. cargo spends in the Soviet transportation system, minimizing instances of damage, loss and pilferage. It is interesting that the Soviet government has not chosen to move U.S. cargo on trains or intercity motor carriers, two modes that are notoriously weak performers in the Soviet economy. Their avoidance of these two modes is probably because of the lack of an intercity highway system similar to ones in western Europe and the U.S., and troubles with the nation's overburdened rail system. The end result, is that the U.S. cargo -- which is primarily perishables and electronics, is moved as most high priority cargo is in the Soviet Union -- by aircraft.

While the Soviet government has forced the nation's transportation system to work well in direct support of the Votkinsk facility, its poor performance still negatively impacts support of the facility. The reason is that the unreliable supply of quality consumer goods in the Votkinsk area has forced the OSIA to import from Europe most of which it consumes at the Votkinsk facility. Unlike the U.S. economy where the transportation system facilitates the distribution of food and consumer items nationwide, the Soviet transportation system, primarily because of its relative lack of roads and the poor state of its rail system, cannot adequately support the reliable, timely nationwide distribution of goods. Therefore, if an item is not produced in a region or if it is on a seasonal basis, it availability is limited. And this is the case for most consumer items in Votkinsk, and why it can be said that the

Soviet transportation system has negatively impacted the Votkinsk facility.

Investigative Question Number Four. Can the distribution system used to support the Votkinsk portal facility be used to support similar facilities under START or will a new system be required?

The existing distribution system will have to be modified if several portal perimeter monitoring facilities are activated in the Soviet Union. The current echelon network of logistics facilities has adequately serviced the one retail outlet at Votkinsk. However, with the multiple retail locations (portal perimeter facilities) which would result under START, it appears that a "direct system" logistics network would be more cost effective in supporting operations at these facilities. A central warehouse should be used to service customer demands rather than using only consolidation warehouses to collect shipments from vendors for onward shipment to the different locations where the shipments are required. The sites will have common spare part and consumables requirements, which will allow safety stocks to be centrally warehoused, reducing overall inventory investment and inventory carrying costs.

Recommendations for Further Research

Clearly, there are many further areas which must be understood by logisticians planning an effective and efficient logistical system to support START portal perimeter monitoring facilities in the Soviet Union. Based on the expert interviews, there is a need for research on locating logistics facilities so that customer service objectives are met at the least total logistics cost. A central warehouse along with distribution centers will be required to support U.S. START facilities. But the question remains, what is the most cost-effective location?

Research should be conducted under a scenario approach using the following total logistics cost components: 1)Transportation, 2)Warehousing, 3) Inventory, 4) Stockout Costs, and 5) Order Processing Costs. Much of the information required for such research was not available in time for this thesis. However, the Votkinsk facility's operations and maintenance contractor should within months of the publication of this thesis have the needed consumption data, bills of material and spare part costs required to do the research.

There could be three scenarios for evaluating the least total cost location of the central warehouse and the general structure of the logistics network. The first scenario is a central warehouse in the Frankfurt, West Germany, area with consolidation warehouses in Albuquerque, NM., Moscow, and in Japan. A second scenario would have a central warehouse in Moscow with consolidation warehouses in Albuquerque, the Frankfurt area and in Japan. The final scenario would be the same as the second, but there would be no consolidation warehouse in Japan. Instead, the Moscow facility would service any START portal in the eastern Soviet Union by relying on premium transportation.

Results from this research could provide a quantitative basis for evaluating possible locations for logistics facilities and the general structure of the distribution network used to support START facilities in the Soviet Urion. It could be used in conjunction with other more qualitative considerations such as political and diplomatic factors in structuring the best possible network to meet mission requirements in implementing the START Treaty.

Appendix A: List of Interviews

Dr. Barry Allen	Former Program Manager, Technical On-Site Inspection (TOSI) Program Office, HQ Electonic Systems Division, Hanscom AFB, MA.
Paul Boren	Chief of START Division, Arms Control and Test Limitations Directorate, Defense Nuclear Agency, Alexandria, VA.
Col George Connell	Director For Portal Monitoring, HQ On-Site Inspection Agency, Herndon, VA.
LTC Mark L. Dues	Site Commander, Votkinsk Portal Monitoring Facility, On-Site Inspection Agency, Votkinsk, U.S.S.R.
Dr. Manfred Eimer	Assistant Director for Bureau of Verification and Intelligence, U.S. Arms Control and Disarmament Agency, Washington D.C.
Michael Embree	Logistics Manager, Technical On-Site Inspection (TOSI) Program Office, Hughes Technical Services Company, Manhattan Beach, CA.
Col Douglas Englund	Chief of Staff, HQ On-Site Inspection Agency, Herndon, VA.
Maj Stephen Freeman	Arms Control Implementation Unit, On-Site Inspection Agency, U.S. Embassy, Moscow, U.S.S.R.
George A. Gecowets	Executive Vice President, Council of Logistics Managment, Oak Brook, IL.
Allan Gloe	Manager, Albuquerque Engineering Liaison Office, Hughes Technical Services Company, Albuquerque, NM.
Maj Charles P. Haver	Deputy Site Commander, Votkinsk Portal Monitoring Facility, On-

	Site Inspection Agency, Votkinsk, U.S.S.R.
Edward Herger	Former Deputy Program Manager for Logistics, Tehnical On-Site Inspection (TOSI) Program Office, HQ Electronic Systems Division, Hanscom AFB, MA.
LTC Gerald R.J. Heuer	Chief of Resource Mana_ Division, HQ On-Site I[illegible]n Agency, Herndon, VA.
CDR Edward Higgins	Negotiations Plans Officer, HQ On-Site Inspection Agency, Herndon, VA.
Col Stephen A. Huff	Director for Support, HQ On-Site Inspection Agency, Herndon, VA.
LTC Gene Johnston (Ret)	Former Verification Analyst, Directorate for Verification Policy, Office of the Under Secretary of Defense for Policy, Washington, D.C.
Maj Michael K. Kelley	Military Advisor for Arms Control; Directorate for Strategy, Arms Control, and Compliance; Office of the Under Secretary of Defense for Acquisition; Washington, D.C.
Rem Langen	Director for Marketing, Moscow McDonald's, McDonald's of Canada, Ltd, Toronto, Canada
Maj Thomas Michaels	Deputy Site Commander, Votkinsk Portal Monitoring Facility, On-Site Inspection Agency, Votkinsk, U.S.S.R.
CDR Charles Myers	Site Commander, Votkinsk Portal Monitoring Facility, On-Site Inspection Agency, Votkinsk, U.S.S.R.
LTC Roy E. Peterson	Site Commander, Votkinsk Portal Monitoring Facility, On-Site Inspection Agency, Votkinsk, U.S.S.R.

James Saunders	Program Manager, Technical On-Site Inspection (TOSI) Program Office, Hughes Technical Services Company, Manhattan Beach, CA.
LTC John Sovich	Former Program Manager, Technical On-Site Inspection (TOSI) Program Office, HQ Electronic Systems Division, Hanscom AFB, MA.
LTC Donald Warmuth (Ret)	Former Program Manager, Technical On-Site Inspection (TOSI) Program Office, HQ Electronic Systems Division, Hanscom AFB, MA.

Appendix B: Interview Guides

Interview Guide: Electronic Systems Division

1. What was the acquisition strategy for the TOSI Program?

2. Why was commercial off the shelve (COTS) equipment used instead of developing program-unique equipment?

3. Why use a civilian contractor to help operate the site and to perform maintenance and logistics support?

4. Logistically, what are the benefits of COTS and using a civilian contractor for support of the site?

5. What are the logistical drawbacks of COTS and using a civilian contractor for support of the site?

6. What do you believe are the most important logistics lessons learned so far from the deployment and operation of the TOSI site?

7. What is your response to the criticism that the system is too sophisticated for the operation at Votkinsk and is difficult to support in terms of dependable and timely resupply of repair parts?

8. Do you believe Votkinsk logistics lessons learned are applicable to logistics planning for U.S. PPM sites in the Soviet Union under the START Treaty?

9. Will there be unique logistics requirements for the START sites, especially in terms of distribution and communication systems networks?

10. Did the general nature of provisions in the INF treaty and its protocols complicate logistics planning and support of the Votkinsk site?

11. Do you think it's practical for U.S. negotiators to work to have more specific language regarding logistics in the START Treaty than in the INF Treaty? If not, what process should be used to conclude specific logistics agreements with the Soviets on support of the Start sites?

12. What is your impression of the Soviet transportation and distribution system?

13. Have the Soviets had any problems providing the logistics support called for in the INF Treaty, its protocols and Memorandums of Agreements?

Interview Guide: On-Site Inspection Agency/Portal Monitoring

1. Logistically, what are the benefits of using commercial off the shelf (COTS) equipment and using a civilian contractor for support of the Votkinsk Portal Monitoring Facility?

2. What are the logistical drawbacks of using COTS and using a civilian contractor for support of the facility?

3. What do you believe are the most important logistics lessons learned so far from the deployment and operation of the facility?

4. Have the Soviets had any problems providing the logistics support called for in the INF Treaty, its protocols and Memorandums of Agreements?

5. Do you believe Votkinsk logistics lessons learned are applicable to logistics planning for U.S. PPM sites in the Soviet Union under the START Treaty?

6. Will there be unique logistics requirements for the START sites, especially in terms of distribution networks for the initial deployment and later on for the resupply of the sites?

7. Did the general nature of the language in the INF treaty and its protocols complicate logistics planning and support of the Votkinsk site?

8. Do you think it's practical for U.S. negotiators to work to have more specific language regarding logistics support in the START Treaty than in the INF Treaty? If not, what process should be used to conclude specific logistics agreements with the Soviets on support of the Start sites?

9. Professional journals and the media in both the Soviet Union and the West point to the Soviet national transportation system as directly contributing to the economic troubles of the Soviet Union. What is your impression of the Soviet transportation and distribution system? How has that system impacted the support of the site?

10. A group of U.S. businessmen who are members of the Council of Logistics Management toured the Soviet Union in 1987. They viewed food production and distribution facilities in several areas of the nation. One member observed that any U.S. business or organization planning to operate at more than one location in the U.S.S.R. would have to set up its own distribution system. Under START, do you

believe the U.S. will need to specifically negotiate for a distribution system to support START sites?

Interview Guide: Hughes Technical Services Company

1. Logistically, what have been the advantages and disadvantages of using commercial-off-the-shelf (COTS) equipment at the Votkinsk Portal Monitoring Facility (VPMF)?

2. What are the advantages of using civilian contractor personnel rather than military personnel for operations and support of the VPMF?

3. Using the ten ILS elements of support as outlined in DODD 5000.39 as a framework, what are the lessons learned so far from the logistics support of the VPMF?

Maintenance Planning?

Manpower and personnel?

Supply Support?

Technical Data?

Training and Training Support?

Computer Resources Support?

Facilities?

Packaging, Handling, Storage and Transportation?

Design Interface?

4. Are there any other logistics lessons learned not necessarily covered by the ILS elements above?

5. Rank the three most important logistics lessons learned?

6. As far as supply support, what are the stock out costs for the VPMF?

7. What is the inventory carrying cost percentage used by HTSC to compute inventory carrying costs?

8. How are you determining what levels spares, food and consumables to stock at the site to meet demand? Are you using some form of EOQ or some other inventory model?

9. In the ISP it was stated that the VPMF would use Soviet vendors whenever possible, primarily for food supply. How dependable has that service been?

10. Has the language in the INF Treaty and its related documents complicated logistics planning and support of the VPMF?

11. What is your impression of the Soviet transportation and distribution system? How has that system impacted support of the site?

12. Do you believe Votkinsk logistics lessons learned are applicable to logistics planning for U.S. portal perimeter monitoring sites in the Soviet Union under START?

13. If there are a network of PPM sites under START, do you believe a logistics support center will be needed in Moscow to support them? Why or why not?

Interview Guide: Pentagon and ACDA

1. Under the INF Treaty, why use continuous portal monitoring facilities to help verify compliance with the treaty by the host nation? Also, why have only one facility in each nation when there may be numerous locations where such a facility is needed to monitor/verify treaty compliance?

2. Why was the Department of Defense selected to implement monitoring and verification activities associated with the INF Treaty?

3. Most of the U.S. personnel stationed at the Votkinsk Portal Monitoring Facility (VPMF) are civilian contract personnel. If the Defense Department is responsible for the operation of the facility, why isn't the site manned entirely by military personnel? What policy considerations influenced the decision to go with primarily contract personnel?

4. Was the INF Treaty negotiated with an eye towards setting precedents for START Treaty negotiations?

5. Can the VPMF be considered as a model for planning support of portal perimeter monitoring (PPM) facilities under START?

6. At what point in arms control talks do negotiators begin discussing "technical" issues such as logistics support procedures and responsibilities?

7. Providing logistics support such as maintenance, spare parts, food and other consumables will be a much larger task under START than under the INF Treaty because of the number of U.S. PPM facilities scattered throughout the USSR. At what point in the negotiation process does the U.S. seek to have a support facility located at or near Sheremetyevo Airport in Moscow to serve as a storage and consolidation point for distribution of materiel to PPM facilities?

8. There is an extensive U.S. government interagency structure, with several committees chaired by officials from the NSC, ACDA and the Defense Department, providing policy guidance and overseeing implementation of monitoring and verification activities associated with the INF Treaty. Will that interagency structure remain intact and pick up the same responsibilities under START? Will the OSIA have a role in START now that it has gained experience implementing the provisions of the INF Treaty?

Interview Guide: On-Site Inspection Agency/
International Negotiations Office

1. Are U.S. negotiators using the INF Treaty, its protocols and Memorandums of Agreements as a baseline for START negotiations?

2. Do you see the Votkinsk and Magna portal monitoring facilities serving as models for START negotiations on continuous portal monitoring facilities?

3. Does the policy community see a big role for the OSIA under the START Treaty? What is that role?

4. Is there a planning estimate or range on how many continuous monitoring facilities each side would operate under START?

5. Do you think it's practical for U.S. negotiators to work to have more specific language regarding logistics support in the START Treaty than in the INF Treaty? If not, what process should be used to conclude specific logistics agreements with the Soviets on support of the Start sites?

6. A group of U.S. businessmen who are members of the Council of Logistics Management toured the Soviet Union in 1987. They viewed food production and distribution facilities in several areas of the nation. One member observed that any U.S. business or organization planning to operate at more than one location in the U.S.S.R. would have to set up its own distribution system. This would include a system of nodes (distribution center(s) and onsite warehouses), transportation linkages and communications links. Under START, do you believe the U.S. will need to specifically negotiate for a distribution system to support START sites?

Interview Guide: Defense Nuclear Agency

1. Do you see logistical benefits in using commercial off the shelf (COTS) equipment at START portal monitoring facilities?
What are the drawbacks?

2. Do you see logistical benefits in using a civilian contractor for support of START portal facilities? What are the drawbacks?

3. What do you believe are the most important logistics lessons learned so far from the deployment and operation of the Votkinks Portal Monitoring Facility?

4. Do you believe Votkinsk logistics lessons learned are applicable to logistics planning for U.S. PPM sites in the Soviet Union under the START Treaty?

5. Will there be unique logistics requirements for the START sites, especially in terms of distribution networks for the initial deployment and later on for the resupply of the sites?

6. Do you think it's practical for U.S. negotiators to work to have more specific language regarding logistics support in the START Treaty than in the INF Treaty? If not, what process should be used to conclude specific logistics agreements with the Soviets on support of the Start sites?

7. A group of U.S. businessmen who are members of the Council of Logistics Management toured the Soviet Union in 1987. They viewed food production and distribution facilities in several areas of the nation. One member observed that any U.S. business or organization planning to operate at more than one location in the U.S.S.R. would have to set up its own distribution system. This would include a system of nodes (distribution center(s) and onsite warehouses), transportation linkages and communications links. Under START, do you believe the U.S. will need to specifically negotiate for a distribution system to support START sites?

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VITA

Captain Richard G. Trembley [redacted]. He was graduated from Old Town High School in Maine and later received a B.S. in Business Economics from Southern Connecticut State College in New Haven. Before he was commissioned in the Air Force, Captain Trembley worked for a little more than six years as a managing editor, writer and photographer for both daily and weekly newspapers. After graduating from Officer Training School in November 1982, he was assigned to F.E. Warren AFB, Wyoming. At Warren, he served as a traffic management officer and a vehicle operations officer with the 90th Transportation Squadron. In 1984, he was assigned to Rhein-Main Air Base, West Germany, where he served as an Air Terminal Operations Center Duty Officer and a Mobile Aerial Port squadron operations officer in the Directorate for Air Transportation, 435th Tactical Airlift Wing. He was transferred from Rhein-Main to Hanscom AFB, MA., in 1987. At Hanscom, he was a staff transportation officer assigned to Headquarters Electronic Systems Division. He entered the School of Systems and Logistics, Air Force Institute of Technology, in 1989. Captain Trembley is married to the former Barbara J. Senich of Princeton, NJ. The Trembleys have three children: Danielle, 15; Tyler, 12, and Sara, 10.

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13. ABSTRACT *(Maximum 200 words)*
This research investigated logistics support for U.S. on-site inspection facilities in the USSR under the INF and START treaties. Specifically, the thesis examined logistics lessons learned from the operation of the U.S.'s Votkinsk Portal Monitoring Facility. A related area of interest was whether those lessons learned are useful for logistics planning for monitoring facilities under the START Treaty. Finally, the research described the distribution network used to move and store material for the Votkinsk facility, and whether that system could be used for a network of START facilities. Based on a literature review and personal interviews, lessons learned were outlined under eight different logistical areas, including maintenance planning; manpower and personnel; supply support; technical data; facilities; packaging, handling, storage and transportation; design interface; and planning. There was a near-consensus by experts interviewed that lessons learned from Votkinsk are valuable for planning logistics support of START facilities. One important conclusion from the lessons learned is that U.S. sites will have to import from the West almost all of what they consume since the Soviet economy cannot reliably provide even the most common comestibles at levels of quality taken for granted in western nations.

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